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DELAWARE RIVER BASIN  
LEHIGH RIVER, LACKAWANNA AND WAYNE COUNTIES

PENNSYLVANIA

LARSEN DAM

NDI ID NO. PA-00367

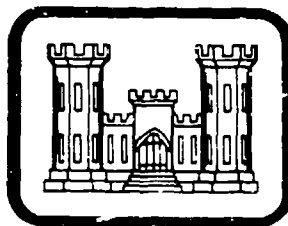
DER ID NO. 35-30

BIG BASS LAKE, INC.

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PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM



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Prepared by  
GANNETT FLEMING CORDDRY AND CARPENTER, INC.  
Consulting Engineers  
Harrisburg, Pennsylvania 17105

For  
DEPARTMENT OF THE ARMY  
Baltimore District, Corps of Engineers  
Baltimore, Maryland 21203

JULY 1981

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DELAWARE RIVER BASIN  
LEHIGH RIVER, LACKAWANNA AND WAYNE COUNTIES  
PENNSYLVANIA

LARSEN DAM

NDI ID No. PA-00367  
DEA ID No. 35-30

BIG BASS LAKE, INC.

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PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM

**DACW31-81-C-0018**

Prepared by

GANNETT FLEMING CORDRY AND CARPENTER, INC.  
Consulting Engineers  
P.O. Box 1963  
Harrisburg, Pennsylvania 17105

For

DEPARTMENT OF THE ARMY  
Baltimore District, Corps of Engineers  
Baltimore, Maryland 21203

JULY 1981

*4-21-007*

## PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

LARSEN DAM  
 NDI ID No. PA-00367; DER ID No. 35-30  
 PHASE I INSPECTION REPORT  
 NATIONAL DAM INSPECTION PROGRAM

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PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam: Larsen Dam  
NDI ID No. PA-00367  
DER ID No. 35-30

Size: Small (11.7 feet high; 504 acre-ft.)

Hazard Classification: High

Owner: Big Bass Lake, Inc.  
L. Larsen, President  
Box 225  
Gouldsboro, PA 18424

State Located: Pennsylvania

County Located: Lackawanna and Wayne

Stream: Lehigh River

Date of Inspection: 2 June 1981

↓  
Based on visual inspection, available records, calculations, past operational performance, and according to criteria established for these studies, Larsen Dam is judged to be in fair condition. Based on the size and hazard classification of the dam, the Spillway Design Flood (SDF) at the dam varies between 1/2 the Probable Maximum Flood (PMF) and the PMF. Based on the downstream conditions, the selected SDF is the 1/2 PMF. Under existing conditions, the spillway will pass about 12 percent of the PMF without overtopping of the dam. If the low areas on the top of the dam were filled to the design elevation, the spillway would pass 16 percent of the PMF. It is judged that Larsen Dam could not withstand the depth and duration of overtopping that would occur during the 1/2 PMF. However, it is judged that a high hazard dam located immediately downstream would fail due to overtopping prior to the overtopping failure of Larsen Dam. Therefore, the spillway capacity of Larsen Dam is rated as inadequate.

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↓  
No immediate stability problems were evident at the time of the inspection, but deficiencies do exist that could eventually affect the stability of the dam and appurtenances if they are not corrected.

↗  
Maintenance of the dam is considered inadequate.

The following studies and remedial measures are recommended to be undertaken by the Owner, in approximate order of priority, without delay:

(1) Design and construct modifications as required to provide adequate spillway capacity.

(2) If the design for spillway modifications does not include provisions for repair of the corewall and replacement of missing embankment material, separate measures should be designed and constructed to accomplish those items.

(3) Remove brush from the dam, replace missing riprap, and fill the burrowing animal hole with impervious material.

(4) Visually monitor the wet area at the toe of the dam. Take appropriate action as required if the condition worsens.

All investigations, studies, designs, and inspection of construction should be performed by a professional engineer experienced in the design and construction of dams.

In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system for Larsen Dam. When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of Larsen Dam.

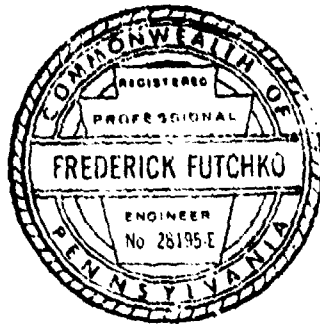
(3) As presently required by the Commonwealth, institute a program of formal annual inspections by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(4) Expand the existing maintenance program and develop a formal maintenance manual so that all features of the dam are properly maintained.

LARSEN DAM

Submitted by:

GANNETT FLEMING CORDDRY  
AND CARPENTER, INC.



*Frederick Futchko*

FREDERICK FUTCHKO  
Project Manager, Dam Section

Date: 7 August 1981

Approved by:

DEPARTMENT OF THE ARMY  
BALTIMORE DISTRICT,  
CORPS OF ENGINEERS

*James W. Peck*  
JAMES W. PECK  
Colonel, Corps of Engineers  
Commander and District Engineer

Date: 18 Aug 81

LARSEN DAM



Overview



## LARSEN DAM

NDI ID No. PA-00367; DER ID No. 35-30

### PHASE I INSPECTION REPORT

#### NATIONAL DAM INSPECTION PROGRAM

#### SECTION 1

#### PROJECT INFORMATION

##### 1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

##### 1.2 Description of Project.

a. Dam and Appurtenances. Larsen Dam consists of an embankment, an overflow spillway, and an outlet works. The embankment is earthfill and has a concrete corewall. The embankment consists of two sections, being divided by the spillway. The section to the right of the spillway is 120 feet long, and the section to the left is 75 feet long. The dam is 11.7 feet high at its highest section.

The spillway is located near the center of the dam. An approach channel leads from the reservoir to a rounded-crest, concrete weir. The weir is 70 feet long and 3.8 feet below the design level for the top of the dam. A concrete apron is located at the bottom of the weir.

The outlet works is located at the left end of the spillway. An intake structure leads from the reservoir to a pair of 24-inch diameter cast-iron pipes. Sluice gates in the intake structure can be used to prevent water from entering the conduits. There are also gate valves located further downstream that can be used to control flows.

The various features of the dam are shown on the Photographs in Appendix C and on the Plates in Appendix E. A description of the geology is included in Appendix F.

b. Location. Larsen Dam is located on the Lehigh River in Clifton Township, Lackawanna County, and Lehigh Township, Wayne County, approximately one-half mile northeast of Gouldsboro, Pennsylvania. Larsen Dam is shown on USGS Quadrangle Sterling, Pennsylvania at latitude N 41° 15' 05" and longitude W 75° 27' 30". On the USGS topographic map, Larsen Lake is shown as Johnson Pond. A location map is shown on Plate E-1.

c. Size Classification. Small (11.7 feet high, 504 acre-feet).

d. Hazard Classification. High hazard. Downstream conditions indicate that a high hazard classification is warranted for Larsen Dam (Paragraphs 3.1e and 5.1c (5)).

e. Ownership. Big Bass Lake, Inc., L. Larsen, President, Box 225, Gouldsboro, PA 18424.

f. Purpose of Dam. Recreation.

g. Design and Construction History. Larsen Dam was constructed in 1910 by the Scranton Gas and Water Company to provide an auxiliary water supply. The dam replaced a timber crib structure that had existed at the site. The dam was designed by W.M. Marple and constructed under the supervision of H. F. Cox, both of whom were engineers for the water company. When it was constructed, the dam was known as Gouldsboro Dam. The lake was later known as Johnson Pond. The dam and lake are now known as Larsen Dam and Larsen Lake. There have been no significant modifications made to the dam since it was constructed.

h. Normal Operational Procedure. The pool is maintained at the spillway crest level with excess inflow discharging over the spillway. The outlet works is used occasionally to draw down the pool level for maintenance purposes.

### 1.3 Pertinent Data.

a. <u>Drainage Area.</u> (square miles)	15.39
b. <u>Discharge at Damsite.</u> (cfs)	
Maximum known flood at damsite	Unknown
Outlet works at maximum pool elevation	110
Spillway capacity at maximum pool elevation	
Design conditions	1,760
Existing conditions	1,300

c.	<u>Elevation.</u> (feet above msl.)	
	<u>Top of dam</u>	
	Design conditions	1886.4
	Existing conditions	1885.7
	<u>Maximum pool</u>	
	Design conditions	1886.4
	Existing conditions	1885.7
	Normal pool (spillway crest)	1882.6
	Upstream invert outlet works	1874.0
	Downstream invert outlet works	1874.0
	Streambed at toe of dam	1874.0
d.	<u>Reservoir Length.</u> (miles)	
	Normal pool	0.75
	Maximum pool (design)	0.80
e.	<u>Storage.</u> (acre-feet)	
	Normal pool	246
	Maximum pool (design)	581
	Maximum pool (existing)	504
f.	<u>Reservoir Surface.</u> (acres)	
	Normal pool	64
	Maximum pool (design)	116
	Maximum pool (existing)	105
g.	<u>Dam.</u>	
	<u>Type</u>	Earthfill with concrete corewall
	<u>Length</u> (feet)	195, embank- ment only
	<u>Height</u> (feet)	11.7
	<u>Topwidth</u> (feet)	
	Design	8.0
	Existing	Varies
	<u>Side Slopes</u>	
	Upstream	
	Design	1V on 4H
	Existing	1V on 4H
	Downstream	
	Design	1V on 3H
	Existing	Varies

g. Dam. (cont'd.)

Zoning

Concrete  
corewall;  
two earthen  
zones

Cutoff

Cutoff trench  
and steel sheet  
piles

Grout Curtain

None

h. Diversion and Regulating  
Tunnel.

None

i. Spillway.  
Type

Concrete weir

Length of Weir (feet)

70.0

Crest Elevation

1882.6

Upstream Channel

Reservoir

Downstream Channel

Concrete apron

j. Regulating Outlets  
Type

Two 24-inch  
diameter  
cast-iron  
pipes

Length (feet)

24

Closure

Sluice gates at  
upstream end;  
gate valves  
near center

Access

Top of dam

SECTION 2  
ENGINEERING DATA

2.1 Design.

a. Data Available. No design data are available for Larsen Dam.

b. Design Features. The project is described in Paragraph 1.2a. The various features of the dam are shown on the Photographs in Appendix C and on the Plates in Appendix E.

c. Design Considerations. Available data are not sufficient to assess the design of the dam.

2.2 Construction Data.

a. Data Available. A report on the dam was prepared in 1915 by the Pennsylvania Water Supply Commission (PWSC). The report was based on information furnished by the engineer who supervised construction of the dam. There is also a drawing prepared in 1914 that was reportedly copied from construction progress sheets. Some of the details from this drawing are shown on Plate E-2.

b. Construction Considerations. Available data indicate that the embankments are constructed of a clay-sand mixture that was obtained locally. Steel sheet piling were driven around the entire dam during construction to provide stable conditions during excavation. The tops of the sheet piles were cut off and the portions remaining were left in place. The corewall in the dam and the concrete spillway are founded on a layer of gravel and boulders that overlie bedrock at the site. A "quicksand stratum" was removed during construction. The 1915 PWSC Report indicates that construction of the dam was satisfactory.

2.3 Operation. There are no formal records of operation. No significant problems have been reported for the dam.

2.4 Evaluation.

a. Availability. Engineering data were provided by the Bureau of Dams and Waterway Management, Department of Environmental Resources, Commonwealth of Pennsylvania (PennDER). Representatives of the Owner were available for information during the visual inspection.

b. Adequacy. The type and amount of available design data and other engineering data are fair, and the assessment is based on the combination of available data, visual inspection, performance history, hydrologic assumptions and hydraulic assumptions, and calculations developed for this report.

c. Validity. There is no reason to question the validity of the available data.

## SECTION 3

### VISUAL INSPECTION

#### 3.1 Findings.

a. General. The overall appearance of the dam is fair. Deficiencies that were observed are noted below. A sketch of the dam with the locations of deficiencies is presented on Exhibit B-1 in Appendix B. Survey information acquired for this report is summarized in Appendix B. Datum used for the survey was the spillway crest level, Elevation 1882.6, as shown on Plate E-2 in Appendix E. On the day of the inspection, the pool was at Elevation 1882.8.

b. Embankment. The survey performed for this inspection showed that the top of the dam is irregular, with the low point at Elevation 1885.7, which is 0.7 foot lower than the design level shown on Plate E-2.

Riprap on the upstream slope of the dam is generally intact but overgrown with brush (Photograph A). The upstream slope generally conforms to the slope angle shown on Plate E-2.

The portion of the embankment to the right of the spillway has the corewall exposed over a 75-foot long reach (Photograph A). The maximum exposed height of corewall is 4.5 feet (Photograph B). About 15 feet to the right of the spillway, the corewall has a 1/8-inch wide crack that extends through the corewall (Photograph C). There is no misalignment at the crack, but concrete at that location has spalled. Near the right abutment there is an area where minor surface erosion of the embankment has occurred (Photographs A and B).

The portion of the embankment to the left of the spillway is completely overgrown with brush (Photograph D). One burrowing animal hole is located on the downstream slope. There is a small wet area located near the toe adjacent to the outlet channel.

c. Appurtenant Structures. The spillway weir was submerged but no major deficiencies appear to exist (Photograph E). There is one crack in the right approach wall of the spillway, and there are numerous locations where surficial deterioration of the approach and outlet walls has occurred (Photographs E and F).

The outlet works is in fair condition. Some deterioration of the concrete intake structure has occurred. The outlet conduits were submerged and could not be inspected. The sluice gates in the intake structure and the gate valves in the outlet conduits are rusted but are reported to be functional.

d. Reservoir Area. The watershed is predominantly wooded and has gentle to moderate slopes. There are five other dams and several small ponds located within the watershed. Larsen Lake itself is segmented into three parts. The Erie-Lackawanna railroad embankment separates one small portion of the reservoir from the main body of water. There is a substantial bridge opening which allows free passage of water through the railroad embankment. There is another earthen embankment which crosses the reservoir and separates a significant portion of the lake from the main body of the reservoir. The top of the embankment is approximately 2 feet above normal pool level, and there is an opening through the embankment about 25 feet wide (Photograph G). The purpose of the embankment is unknown.

e. Downstream Conditions. Lake Lehigh Dam, DER I.D. No. 64-51, is located 0.7 mile downstream from Larsen Dam. Lake Lehigh Dam (Photograph H) was inspected in 1980 and found to be a high hazard dam. The available surcharge storage in Lake Lehigh is 31 acre-feet, compared to the 246 acre-feet of storage in Larsen Lake at normal pool level. If Larsen Dam were to fail, it could cause failure of Lake Lehigh Dam. Accordingly, Larsen Dam is a high hazard dam.



## SECTION 4

### OPERATIONAL PROCEDURES

4.1 Procedure. The reservoir is normally maintained at spillway crest level, with excess inflow discharging over the spillway and into the Lehigh River. The outlet works is used occasionally to draw down the pool for maintenance purposes.

4.2 Maintenance of Dam. The dam is visited at least monthly by one of the Owner's representatives. Based on the condition of the dam, it is evident that maintenance of the dam has been minimal. Formal inspections of the dam are not made.

4.3 Maintenance of Operating Facilities. The outlet works operating mechanisms are rusted but are reported to be in good working order. Maintenance is limited to checking the operation of the gate valves several times each year.

4.4 Warning Systems in Effect. There is no emergency operation and warning system.

4.5 Evaluation of Operational Adequacy. The maintenance of the dam and appurtenant works is inadequate, as evidenced by the maintenance deficiencies observed during the visual inspection. A program of formal annual inspection is necessary to detect potentially hazardous conditions. A detailed emergency operation and warning system is necessary to reduce the risk of dam failure should adverse conditions develop and to prevent loss of life should the dam fail.

## SECTION 5

### HYDROLOGY AND HYDRAULICS

#### 5.1 Evaluation of Features.

a. Design Data. The 1915 Report by the PWSC indicated that the design capacity of the spillway was 1,650 cfs, based on a maximum available head of 3.5 feet. For this inspection it was determined that the design capacity of the spillway is 1,760 cfs, based on a maximum available head of 3.8 feet.

b. Experience Data. There are no known records of the maximum pool elevation at Larsen Dam.

#### c. Visual Observations.

(1) General. The visual inspection of Larsen Dam, which is described in Section 3, resulted in a number of observations relevant to hydrology and hydraulics. These observations are evaluated herein.

(2) Embankment. The top of the embankment is 0.7 foot lower than its design elevation. Accordingly, the existing spillway capacity is less than its design capacity.

Although the available records contain no reference to overtopping of the dam, the visual inspection and photographs from the records strongly suggest that the dam has been overtopped. A photograph taken in 1938 clearly shows that the entire embankment to the right of the spillway was intact and that no portions of the corewall were exposed. A photograph taken in 1957 shows the corewall exposed to approximately the same extent that exists now. Based on the visual inspection and the photographs, it is surmised that the dam was overtopped, possibly during the 1955 flood, and that the embankment suffered severe erosion.

(3) Appurtenant Structures. No deficiencies relevant to hydraulics were observed at the spillway or the outlet works.

(4) Reservoir Area. Nothing was observed in the reservoir area that would present a hazard to the dam. The segmentation of the reservoir caused by the two earthen embankments is of little significance, and the minor effects that they might have were not included in the analysis performed for this report.

There are five dams upstream from Larsen Dam, as noted in Appendix D. Phase I National Dam Inspection Reports have been prepared for four of these dams. The effects of all the dams

have been included in the analysis described hereafter. Of these five dams, only Lake Watawga Dam and Gouldsboro Dam are considered to present any noteworthy hazard to Larsen Dam. Gouldsboro Dam has an adequate spillway capacity. Lake Watawga Dam has a seriously inadequate spillway capacity.

(5) Downstream Conditions. Lake Lehigh Dam is located immediately downstream from Larsen Dam, as shown on Exhibit D-1 in Appendix D. A Phase I National Dam Inspection Report has previously been prepared for Lake Lehigh Dam, which is a small, high hazard dam with a seriously inadequate spillway capacity. Since a failure of Larsen Dam could cause a failure of Lake Lehigh Dam, a high hazard classification is warranted for Larsen Dam.

d. Overtopping Potential.

(1) Spillway Design Flood. According to the criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (small) and hazard potential (high) of Larsen Dam is between one-half of the Probable Maximum Flood (PMF) and the PMF. Based on the small height of the dam and the downstream conditions, the 1/2 PMF is selected as the SDF for Larsen Dam. The watershed and reservoir were modeled with the U.S. Army Corps of Engineers HEC-1DB computer program. A description of the model is included in Appendix D. The assessment of hydrology and hydraulics is based on existing conditions, and the effects of future development are not considered.

(2) Summary of Results. Pertinent results are tabulated at the end of Appendix D. The analysis reveals that the existing Larsen Dam can pass about 12 percent of the PMF before overtopping of the dam occurs. If the low areas on the top of the dam were raised to the design elevation, the dam could pass 16 percent of the PMF. During the 1/2 PMF, the dam would be overtopped by 3.6 feet for 19 hours. This would cause the dam to fail.

(3) Spillway Adequacy. The criteria used to rate the spillway adequacy of a dam are described in Appendix D. Because Larsen Dam cannot pass the 1/2 PMF, further analysis was performed. The outflow from Larsen Dam was routed through Lake Lehigh and over Lake Lehigh Dam. Larsen Dam passes the 5 percent PMF with 1.4 feet of freeboard. The outflow from Larsen Dam during the 5 percent PMF will cause Lake Lehigh to overtop by 0.7 foot for 17.8 hours. The Phase I Report for Lake Lehigh Dam indicates that it would start failing during an overtopping of 0.5 foot. Therefore, it was judged that dwellings downstream would already be flooded by the failure of Lake Lehigh Dam before Larsen Dam started to fail. The spillway capacity of Larsen Dam is rated as inadequate.

The Commonwealth is presently reviewing plans for the rehabilitation of Lake Lehigh Dam. The plans include increasing the spillway capacity of Lake Lehigh Dam to pass the 1/2 PMF. When the rehabilitation is completed, the existing spillway capacity of Larsen Dam would pose more of a hazard to Lake Lehigh Dam and the dwellings downstream.

SECTION 6  
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Larsen Dam, which is described in Section 3, resulted in a number of observations relevant to structural stability. These observations are evaluated herein for the various features.

(2) Embankment. The growth of brush on the embankment slopes will eventually create a potential hazard to the dam. The root systems create potential paths along which seepage can develop. The exposed corewall is an undesirable condition. Although the amount of exposure does not create a stability hazard under normal conditions, a small amount of overtopping would cause rapid progressive erosion that would probably result in failure of the dam. The crack in the corewall is also undesirable because of the leakage that would occur under high pool levels. The bare areas at the right abutment would allow erosion to occur rapidly if the dam were overtopped. The burrowing animal hole located on the downstream slope is minor but should be filled. The wet area at the toe to the left of the spillway is considered to be relatively minor but warrants monitoring.

(3) Appurtenant Structures. The deficiencies at the spillway, a crack in the right approach wall and surficial deterioration of the concrete, are maintenance problems that do not constitute significant hazard to the dam. Nothing was observed at the outlet works that constitutes a hazard to the dam.

b. Design and Construction Data. No stability analyses are available for the embankment or spillway. Based on review of the sections that are available, the stability of the dam is judged to be adequate for its original design conditions.

c. Operating Records. There are no formal records of operation. No stability problems are known to have occurred since the dam was constructed in 1910.

d. Post-construction Changes. There have been no post-construction changes to the dam.

e. Seismic Stability. Larsen Dam is located in Seismic Zone 1. Normally, it can be considered that if a dam in this zone has adequate factors of safety under static loading conditions, it can be assumed safe for any expected earthquake loading. Since the factors of safety are assumed to be adequate, the dam is also assumed to be stable for any expected earthquake loading.

SECTION 7  
ASSESSMENT, RECOMMENDATIONS, AND  
PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment

a. Safety.

(1) Based on available records, visual inspection, calculations, and past operational performance, Larsen Dam is judged to be in fair condition. Based on the size and hazard classification of the dam, the recommended SDF varies between the 1/2 PMF and the PMF. The selected SDF for the dam is the 1/2 PMF. Based on existing conditions, the spillway will pass about 12 percent of the PMF without overtopping of the dam. If the low areas on the top of the dam were filled to the design elevation, the spillway would pass 16 percent of the PMF. It is judged that Larsen Dam could not withstand the depth and duration of overtopping that would occur during the 1/2 PMF. However, it is judged that a high hazard dam located immediately downstream would fail due to overtopping prior to the overtopping failure of Larsen Dam. Therefore, the spillway capacity of Larsen Dam is rated as inadequate.

(2) No immediate stability problems were evident at the time of the inspection, but deficiencies do exist that could eventually affect the stability of the dam and appurtenances if they are not corrected.

(3) Maintenance of the dam is considered inadequate.

(4) A summary of the features and observed deficiencies is listed below:

<u>Feature</u>	<u>Observed Deficiency</u>
Embankment:	Low areas on top; brush on slopes; surface erosion; corewall exposed and cracked; missing riprap; burrowing animal hole; wet area at toe.
Spillway:	Crack in approach wall; concrete deteriorated.
Outlet Works:	Crack in intake structure; operating mechanisms rusted.

b. Adequacy of Information. The information available is such that an assessment of the condition of the dam can be inferred from the combination of visual inspection, past performance, and computations performed prior to and as part of this study.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented without delay.

d. Necessity for Further Investigations. Accomplishment of the remedial measures outlined in Paragraph 7.2, will require further investigations by the Owner.

## 7.2 Recommendations and Remedial Measures.

a. The following studies and remedial measures are recommended to be undertaken by the Owner, in approximate order of priority, without delay:

(1) Design and construct modifications as required to provide adequate spillway capacity.

(2) If the design for spillway modifications does not include provisions for repair of the corewall and replacement of missing embankment material, separate measures should be designed and constructed to accomplish those items.

(3) Remove brush from the dam, replace missing riprap, and fill the burrowing animal hole with impervious material.

(4) Visually monitor the wet area at the toe of the dam. Take appropriate action as required if the condition worsens.

All investigations, studies, designs, and inspection of construction should be performed by a professional engineer experienced in the design and construction of dams.

b. In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system for Larsen Dam. When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of Larsen Dam.



(3) As presently required by the Commonwealth, institute a program of formal annual inspections by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(4) Expand the existing maintenance program and develop a formal maintenance manual so that all features of the dam are properly maintained.

APPENDIX A

CHECKLIST - ENGINEERING DATA

## CHECKLIST

NAME OF DAM: Larsen Dam

## ENGINEERING DATA

NDI ID NO.: PA-00367 DER ID NO.: 35-30DESIGN, CONSTRUCTION, AND OPERATION  
PHASE ISheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	One drawing available in PennDER files. Pertinent sections reproduced on Plate E-2 in Appendix E.
REGIONAL VICINITY MAP	See Location Map, Plate E-1.
CONSTRUCTION HISTORY	Constructed 1910 by Scranton Gas and Water Company. Originally known as Gouldsboro Dam, later as Johnson Pond Dam. No significant modifications since 1910.
TYPICAL SECTIONS OF DAM	See Plate E-2.
OUTLETS: Plan Details Constraints Discharge Ratings	See Plate E-2 for plan and details. No discharge ratings available.

## ENGINEERING DATA

Sheet 2 of 4

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	None available.
DESIGN REPORTS	Description of design contained in 1915 report prepared by the Commonwealth.
GEOLOGY REPORTS	Geologic information contained in 1915 report and shown on Plate E-2. For general geology, see Appendix F.
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	None.
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	Described in 1915 Report.
POSTCONSTRUCTION SURVEYS OF DAM	None.

# ENGINEERING DATA

Sheet 3 of 4

ITEM	REMARKS
BORROW SOURCES	<i>Borrow obtained locally.</i>
MONITORING SYSTEMS	<i>None.</i>
MODIFICATIONS	<i>None reported.</i>
HIGH POOL RECORDS	<i>None.</i>
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	<i>None.</i>
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	<i>None reported.</i>

## ENGINEERING DATA

Sheet 4 of 4

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	<i>None.</i>
SPILLWAY: Plan Sections Details	<i>See plate E-2.</i>
OPERATING EQUIPMENT: Plans Details	<i>See plate E-2.</i>
PREVIOUS INSPECTIONS Dates Deficiencies	<i>1914: Good condition.</i> <i>1938: Erosion of embankment at rt. abutment.</i> <i>1957: Fair condition.</i>

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: Larsen Dam County: Lackawanna / Wayne State: Pennsylvania  
NDI ID No.: PA-Q0367 DER ID No.: 35-30  
Type of Dam: Earthfill with concrete corewall Hazard Category: High  
Date(s) Inspection: 2 June 1981 Weather: Light rain Temperature: 65°

Pool Elevation at Time of Inspection: 1882.8 msl/Tailwater at Time of Inspection: 1877.9 msl

Inspection Personnel:

A. H. Whitman (GEGG)

D. R. Ebersele (GEGG)

D. B. Wilson (GEGG) Recorder



# EMBANKMENT

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None apparent on embankment. 1/8" wide near-vertical crack in corewall approx. 15' right of spillway.	Portions of embankment obscured by brush.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None.	
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	Downstream slope: length of corewall exposed possibly due to erosion during overtopping; general surface erosion on embankment to rt. of spillway. Upstream slope: minor erosion at intake structure and at spillway.	Maximum exposed height of corewall is 4.5'. Approx. 75' length is exposed. See Sheet B-10 for section.
CREST ALIGNMENT: Vertical Horizontal	Horizontal - no deficiencies. Vertical - irregular; see Sheet B-9	
RIPRAP FAILURES	Missing riprap over 3'x2' area 20' left of intake.	

# EMBANKMENT

Sheet 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
FUNCTION OF EMBANKMENT WITH: Abutment Spillway Other Features	Surface erosion at various locations as described previously.	
ANY NOTICEABLE SEEPAGE	Approx. 5' diameter wet area at toe to left of spillway.	Source indeterminate. Does not appear to be serious hazard.
STAFF GAGE AND RECORDER	None.	
DRAINS	None.	
BRUSH / TREES / VISC.	Brush on upstream slope both sides of spillway. Brush on downstream slope left of spillway.	One burrowing animal hole on d/s slope to left of spillway.

# OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Twin 24-inch diameter cast-iron outlet conduits submerged.	
INTAKE STRUCTURE	Concrete structure; bar screen at intake; large vertical crack in intake structure.	Concrete deteriorated at upstream end of approach wall.
OUTLET STRUCTURE	Submerged.	
OUTLET CHANNEL	Stream channel; large pool at outlet area.	
EMERGENCY GATE	Two slide gates at intake structure. Two gate valves in manholes on platform.	Equipment rusty but in fair condition. Owner reported valves operated 1 week prior to inspection.

# UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	<i>Submerged. No readily apparent deficiencies.</i>	
APPROACH CHANNEL	<i>Reservoir; no obstructions. One crack in right approach wall near upstream end.</i>	
DISCHARGE CHANNEL	<i>Superficial deterioration of concrete outlet channel walls.</i>	
BRIDGE AND PIERS	<i>None.</i>	

# INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	<i>None.</i>	
OBSERVATION WELLS	<i>None.</i>	
WEIRS	<i>None.</i>	
PIEZOMETERS	<i>None.</i>	
OTHER	<i>None.</i>	

# DOWNSTREAM CHANNEL

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
<b>CONDITION:</b> Obstructions Debris Other	No obstructions or debris.	
<b>SLOPES</b>	Vary from mild to steep; brush- covered.	
<b>APPROXIMATE NUMBER OF HOMES AND POPULATION</b>	Lake Lehigh Dam located 2.7 mile downstream. Several dwellings 1.7 miles from dam.	Lake Lehigh Dam inspected October 1980 and classified as high hazard.

# RESERVOIR AND WATERSHED

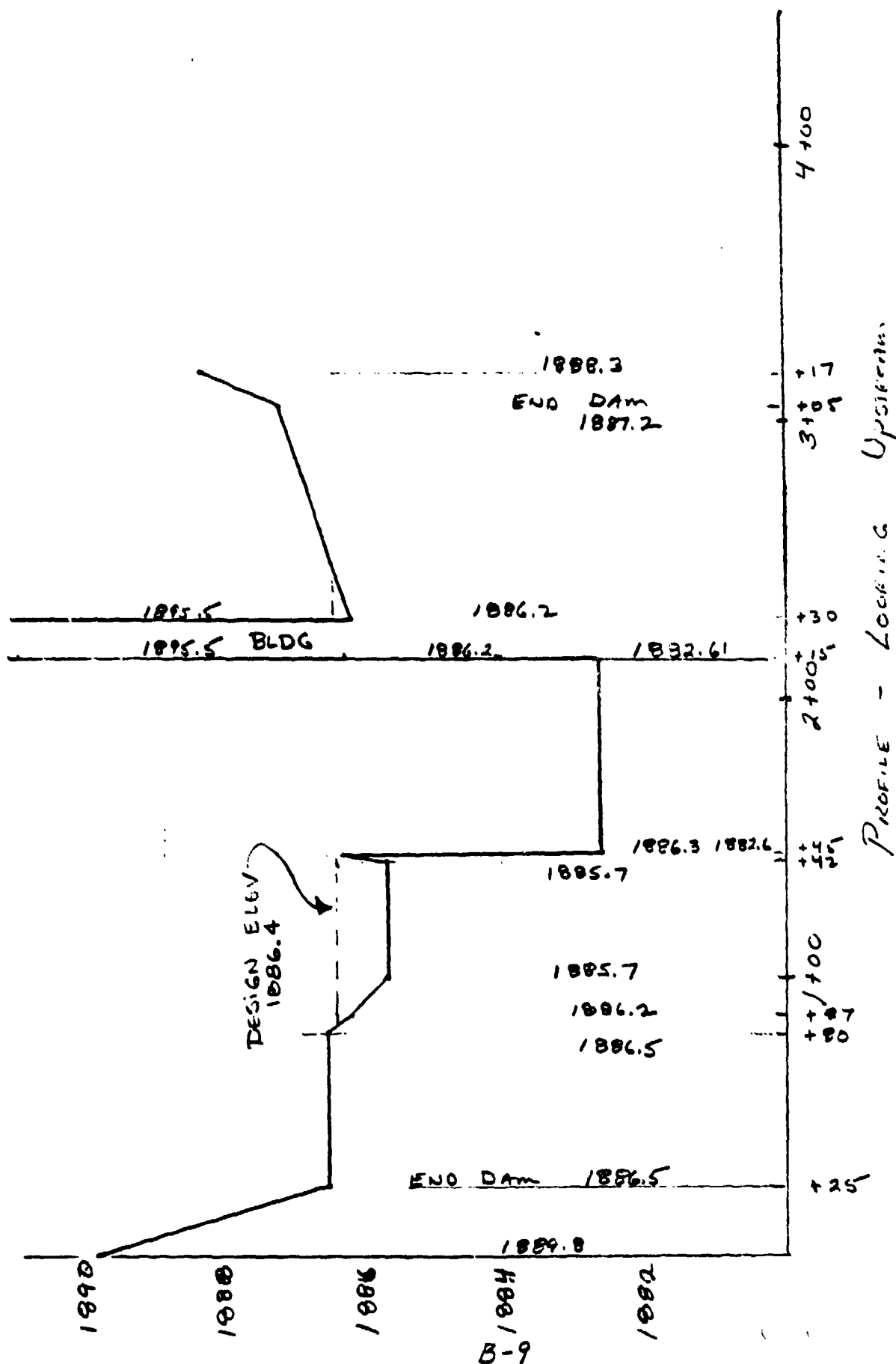
Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Mild to moderate slopes surrounding reservoir. Mostly wooded.	
SEDIMENTATION	Unknown.	
WATERSHED DESCRIPTION	Five dams and several small ponds in watershed. Watershed mostly wooded.	See Appendix D for description of upstream dams.

BY \_\_\_\_\_ DATE \_\_\_\_\_  
CHKD BY \_\_\_\_\_ DATE \_\_\_\_\_

SUBJECT \_\_\_\_\_  
LARSEN DAM

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_  
JOB NO. \_\_\_\_\_





BY \_\_\_\_\_ DATE \_\_\_\_\_  
CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

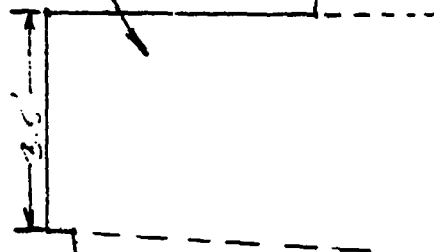
SUBJECT \_\_\_\_\_  
LARSEN DAM

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_  
JOB. NO. \_\_\_\_\_

30

DOWNSTREAM

CONCRETE COREWALL



1  
20

SECTION THROUGH EMBANKMENT  
TO RIGHT OF SPILLWAY

UPSTREAM

—1087

—1086

—1085

—1084

—1082

—1081

—1080

—1079

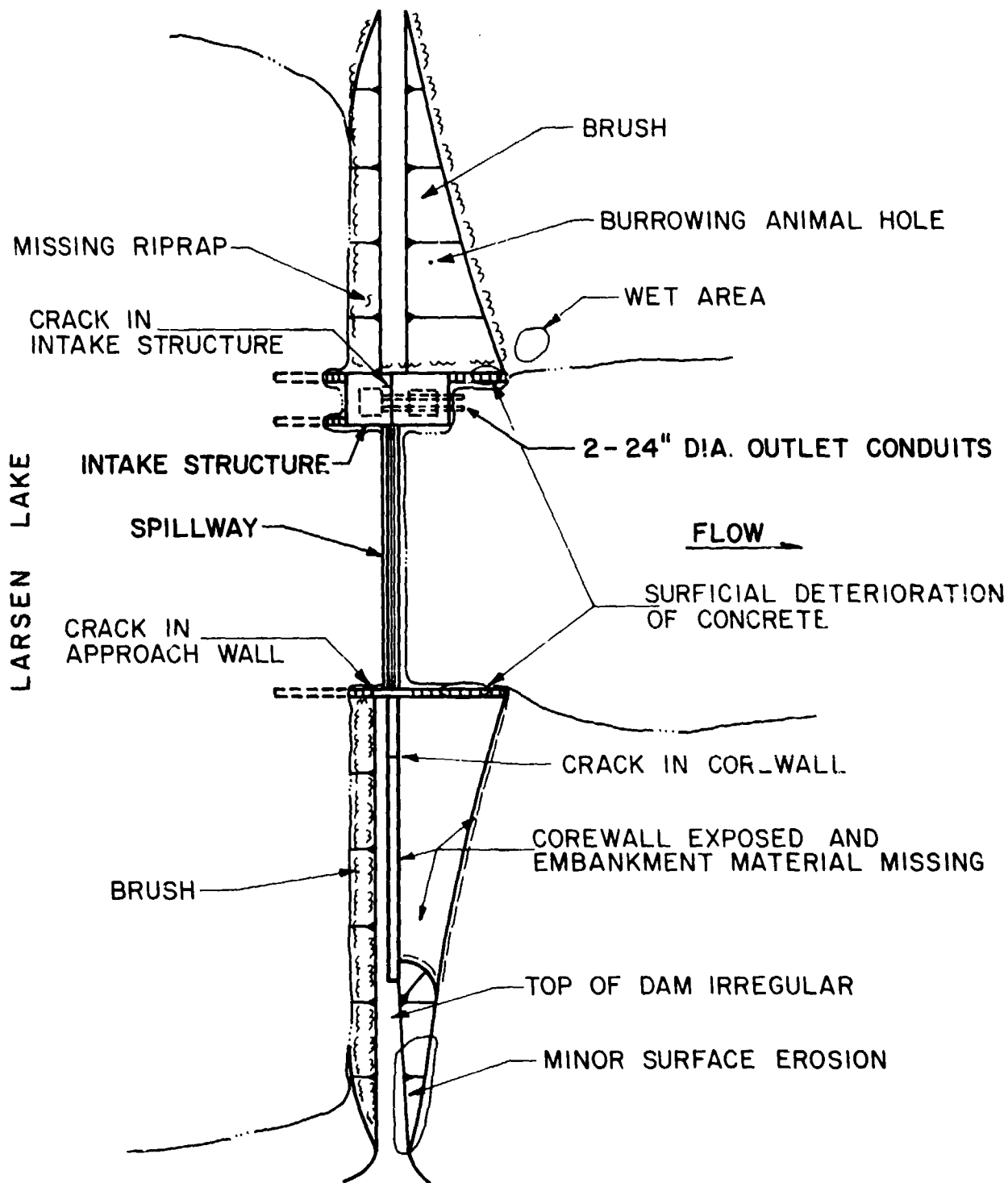
—1078

—1077

B-10

1  
10

DATE OF INSPECTION: 2 JUNE 1981  
POOL ELEVATION: 1882.8



NOT TO SCALE

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM

LARSEN DAM

BIG BASS LAKE, INC.

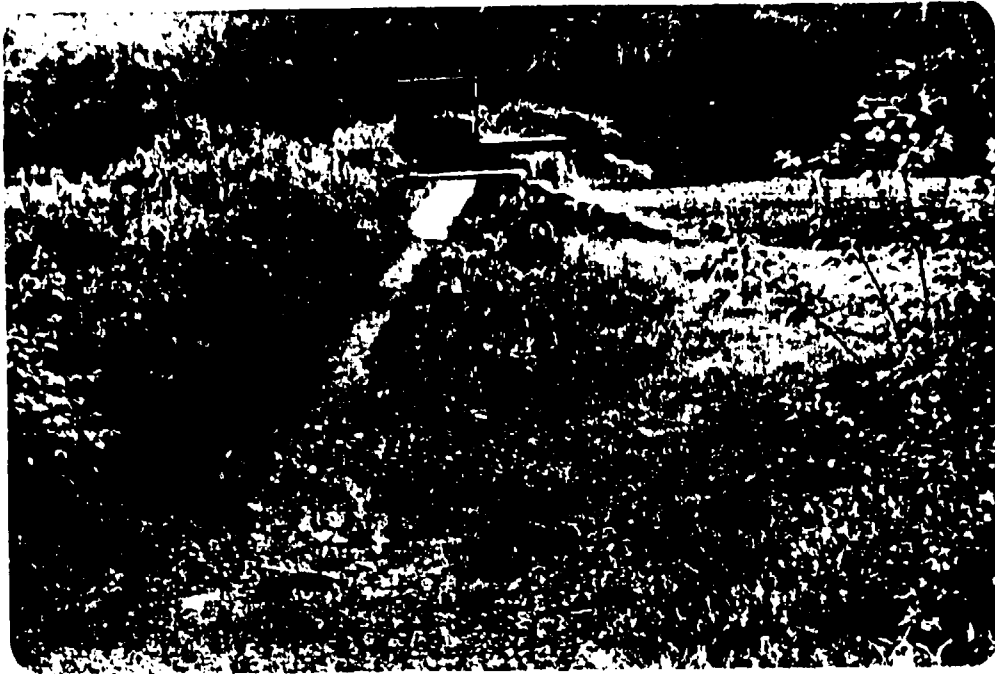
RESULTS OF  
VISUAL INSPECTION

JULY 1981

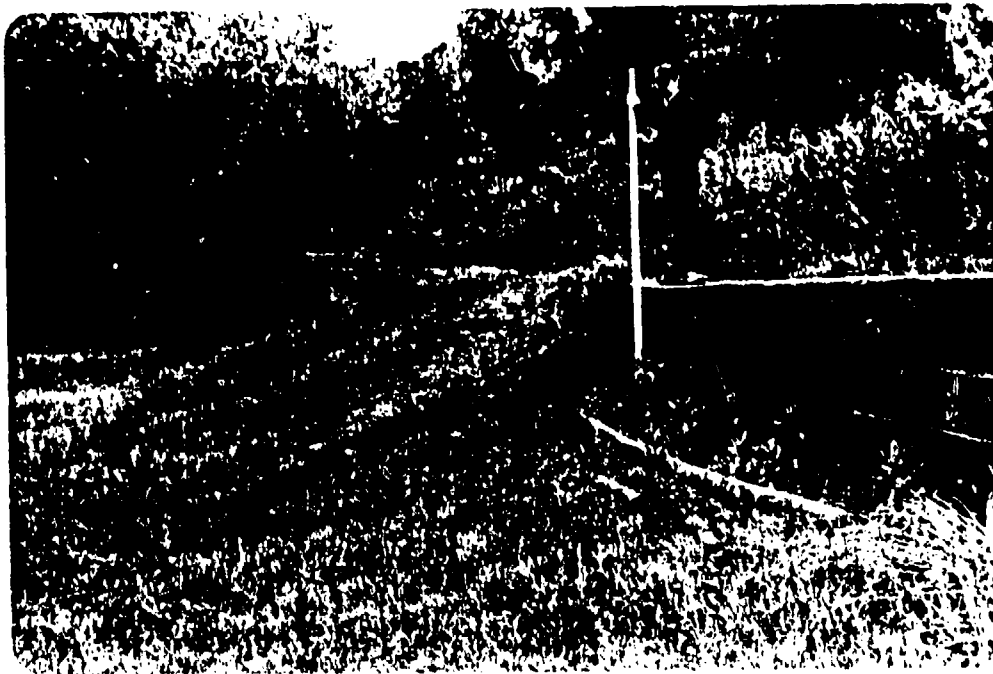
EXHIBIT B-1

APPENDIX C  
PHOTOGRAPHS

LARSEN DAM



A. Embankment and Spillway



B. Exposed Corewall and Surface Erosion  
Near Right Abutment

LARSEN DAM



C. Crack in Corewall

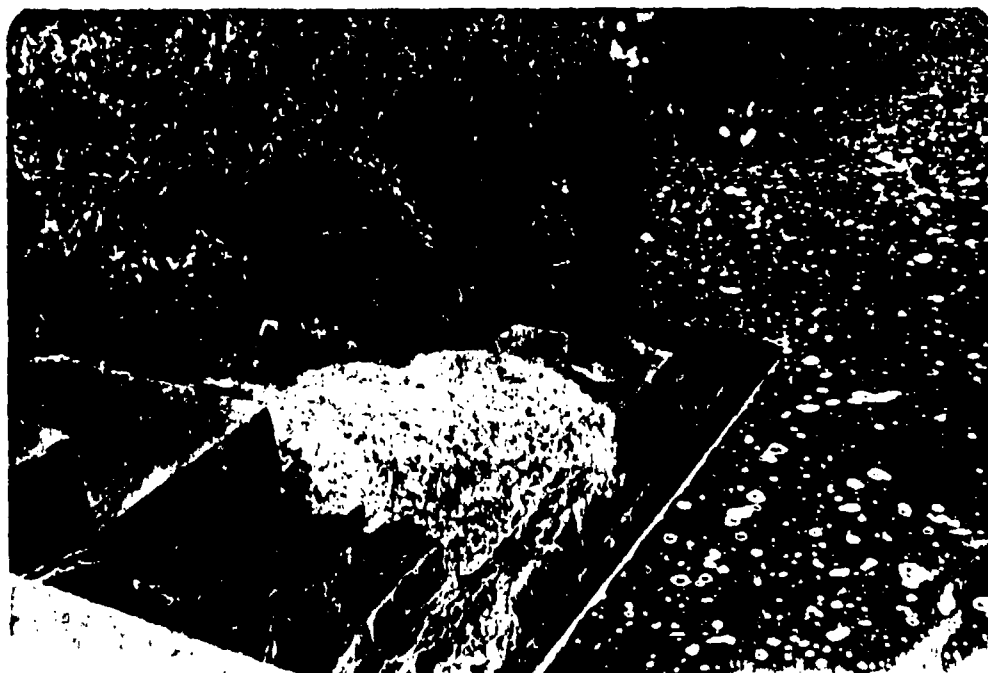


D. Embankment Section to Left of Spillway

LARSEN DAM

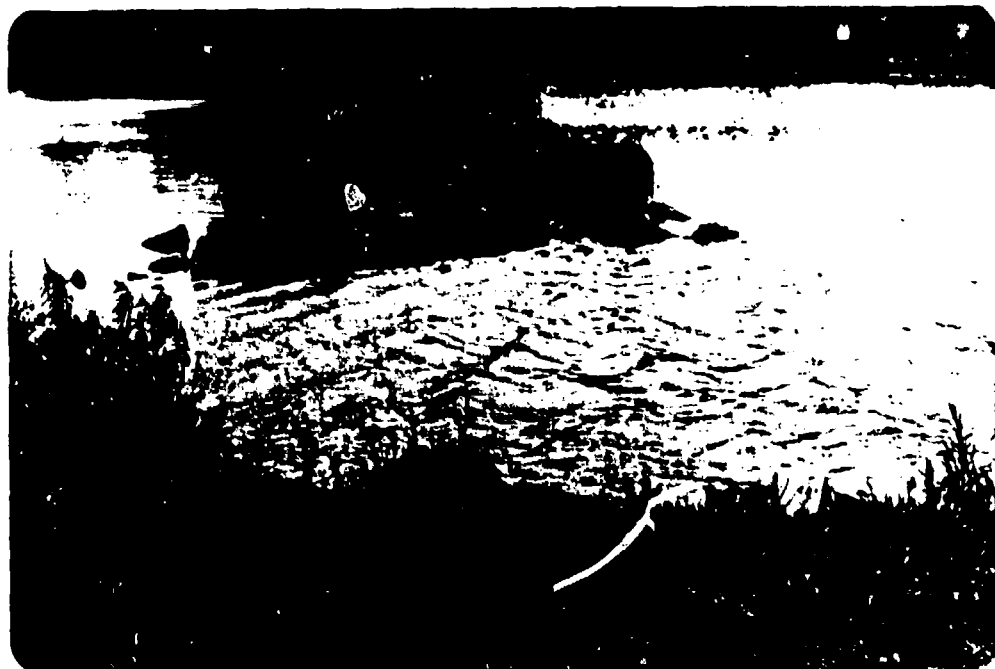


E. Spillway and Intake Structure



F. Typical Concrete Deterioration  
at Spillway and Outlet Works

LARSEN DAM

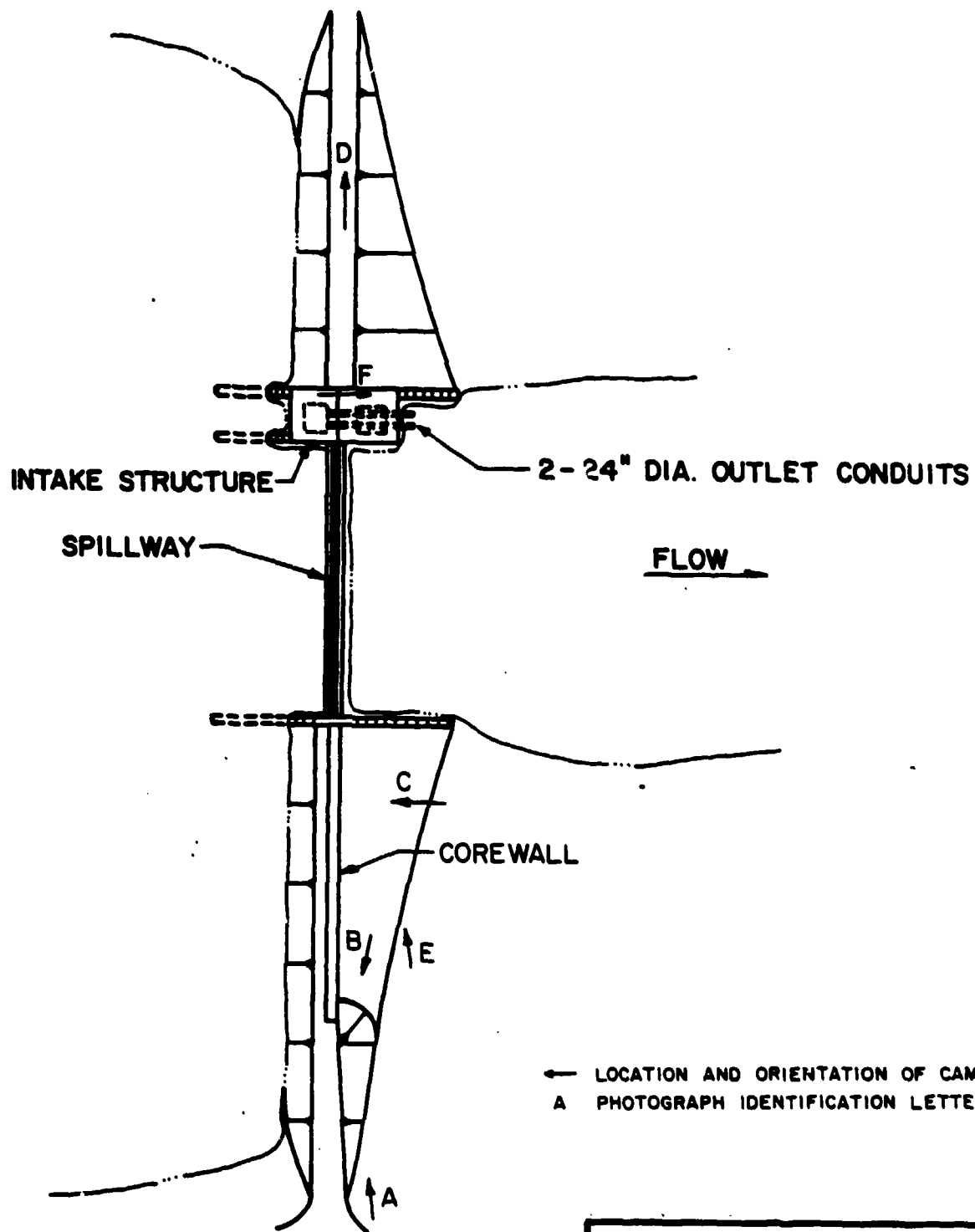


G. Embankment in Reservoir Area



H. Lake Lehigh Dam - Located 0.7 Mile Downstream

LARSEN LAKE



NOT TO SCALE

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM

LARSEN DAM

BIG BASS LAKE, INC.

GUIDE TO LOCATION  
OF PHOTOGRAPHS

JULY 1981

EXHIBIT C-1



APPENDIX D  
HYDROLOGY AND HYDRAULICS

## APPENDIX D

### HYDROLOGY AND HYDRAULICS

#### Spillway Capacity Rating:

In the recommended Guidelines for Safety Inspection of Dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended Spillway Design Flood (SDF) for the size (small, intermediate, or large) and hazard potential (low, significant, or high) classification of a dam is selected in accordance with the criteria. The SDF for those dams in the high hazard category varies between one-half of the Probable Maximum Flood (PMF) and the PMF. If the dam and spillway are not capable of passing the SDF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, or if the dam is not in the high hazard category, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

- (a) There is a high hazard to loss of life from large flows downstream of the dam.
- (b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.
- (c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

#### Description of Model:

If the Owner has not developed a PMF for the dam, the watershed is modeled with the HEC-1DB computer program, which was developed by the U.S. Army Corps of Engineers. The HEC-1DB computer program calculates a PMF runoff hydrograph (and percentages thereof) and routes the flows through both reservoirs and stream sections. In addition, it has the capability to simulate an overtopping dam failure. By modifying the rainfall criteria, it is also possible to model the 100-year flood with the program.

# APPENDIX D

DELAWARE River Basin

Name of Stream: LEHIGH RIVER  
 Name of Dam: LARSEN  
 NDI ID No.: PA-00367  
 DER ID No.: 35-30  
 Latitude: N 41° 15.1' Longitude: W 75° 27.5'  
 Top of Dam Elevation: 885.7  
 Streambed Elevation: 1874.0 Height of Dam: 11.7 ft  
 Reservoir Storage at Top of Dam Elevation: 304 acre-ft  
 Size Category: SMALL  
 Hazard Category: HIGH (see Section 5)  
 Spillway Design Flood: VARIES 1/2 PMF TO PMF  
SELECT 1/2 PMF

## UPSTREAM DAMS

Name	Distance from Dam (miles)	Height (ft)	Storage at top of Dam Elevation (acre-ft)	Remarks
* <u>CRYSTAL LAKE</u>	<u>3.8</u>	<u>13</u>	<u>753</u>	<u>DER ID 64-6</u>
<u>UPPER KLONDIKE</u>	<u>0.9</u>	<u>14</u>	<u>181</u>	<u>DER ID 64-173</u>
* <u>LOWER KLONDIKE</u>	<u>0.6</u>	<u>18</u>	<u>219</u>	<u>DER ID 64-173</u>
* <u>LAKE WATAWGA</u>	<u>1.5</u>	<u>12</u>	<u>654</u>	<u>DER ID 64-38</u>
* <u>GOULDSBORO</u>	<u>1.7</u>	<u>18</u>	<u>1500</u>	<u>DER ID 64-148</u>

## DOWNSTREAM DAMS

* <u>LAKE LEHIGH</u>	<u>0.7</u>	<u>10</u>	<u>163</u>	<u>DER ID 64-51</u>

Except for LARSEN Dam,

DATA HEREIN OBTAINED FROM PHASE I  
 REPORTS FOR THE VARIOUS DAMS.

\* Phase I Report previously prepared.

DELAWARE

River Basin

Name of Stream: LEHIGH RIVER

Name of Dam: LARSEN

DETERMINATION OF PMF RAINFALL & UNIT HYDROGRAPH

UNIT HYDROGRAPH DATA:

Sub-area	Drainage Area (square miles)	Cp (1)	Ct (2)	L miles (3)	L <sub>ca</sub> miles (4)	L' miles (5)	Tp hours (6)	Map Area (7)	Plate (8)
A-1	2.57	0.45	2.1	2.08	0.61	N/A	2.26	2	B
A-2	3.88	0.45	2.1	N/A	N/A	2.40	3.55	2	B
A-3	0.42	0.45	2.1	1.89	0.70	N/A	2.28	2	B
A-4	0.77	0.45	2.1	N/A	N/A	0.59	1.53	2	B
A-5	4.69	0.45	2.1	3.41	2.03	N/A	3.75	2	B
A-6	0.17	0.45	2.1	N/A	N/A	0.40	1.21	2	B
A-7	2.89	0.45	2.1	2.69	1.01	N/A	2.83	2	B
Total	15.39								

(See Sketch on Sheet D-4)

(1) & (2): Snyder Unit Hydrograph coefficients supplied by Baltimore District, Corps of Engineers on maps and plates referenced in (7) & (8)

The following are measured from the outlet of the subarea:

(3): Length of main watercourse extended to divide

(4): Length of main watercourse to the centroid

The following is measured from the upstream end of the reservoir at normal pool:

(5): Length of main watercourse extended to divide

(6):  $Tp = C_t \times (L \times L_{ca})^{0.3}$ , except where the centroid of the subarea is located in the reservoir. Then

$Tp = C_t \times (L')^{0.6}$

Initial flow is assumed at 1.5 cfs/sq. mile

Computer Data: QRCSN = -0.05 (5% of peak flow)

RTIOR = 2.0

RAINFALL DATA:

PMF Rainfall Index = 21.9 in., 24 hr., 200 sq. mile  
Hydromet. 40 Hydromet. 33  
(Susquehanna Basin) (Other Basins)

Zone: N/A

Geographic Adjustment

Factor:

N/A

1.0

Revised Index

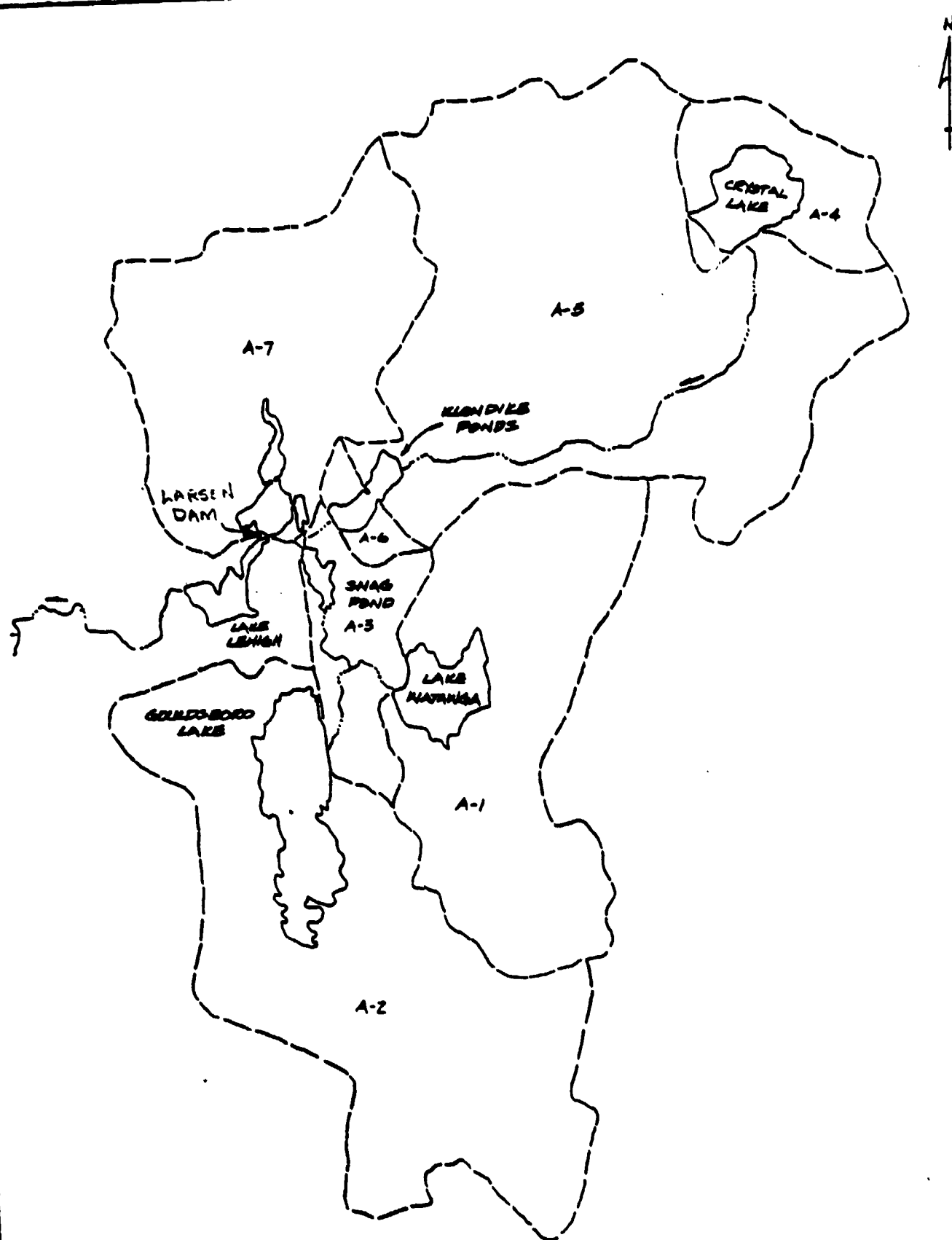
Rainfall:

N/A

21.9

RAINFALL DISTRIBUTION (percent)

Time	Percent
6 hours	<u>106</u>
12 hours	<u>119</u>
24 hours	<u>129</u>
48 hours	<u>138</u>
72 hours	<u>      </u>
96 hours	<u>      </u>



--- WATERSHED  
BOUNDARY

— WATER COURSE

LARSEN DAM  
SKETCH OF SYSTEM

Data for Dam at Outlet of Subarea A-1 (See sketch on Sheet D-4)

Name of Dam: LAKE WATAUGA DAM

STORAGE DATA: TAKEN FROM PHASE I REPORT  
FOR LAKE WATAUGA DAM

Elevation	Area (acres)	Storage		Remarks
		million gals	acre-ft	
<u>1909.4</u> =ELEVO*	<u>0</u>	<u>0</u>	<u>0</u>	<u>STREAMBED</u>
<u>1920.0</u> =ELEV1	<u>125</u> =A1	<u>144</u>	<u>442</u> =S1	<u>NORMAL POOL</u>
<u>1921.6</u>	<u>140</u>	<u>213</u>	<u>654</u>	<u>TOP OF DAM</u>
<u>1940.0</u>	<u>376</u>			

\* ELEVO = ELEV1 -  $(3S_1/A_1)$

\*\* Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 8 percent of subarea watershed.

BREACH DATA: BREACH ANALYSIS NOT REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: \_\_\_\_\_

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) \_\_\_\_\_ fps  
(from  $Q = CLH^{3/2} = V \cdot A$  and depth =  $(2/3) \times H$ ) &  $A = L \cdot \text{depth}$

HMAX =  $(4/9 V^2/C^2)$  = \_\_\_\_\_ ft., C = \_\_\_\_\_ Top of Dam El. = \_\_\_\_\_

HMAX + Top of Dam El. = \_\_\_\_\_ = FAILURE  
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = \_\_\_\_\_ ft (width of bottom of breach)  
Z = \_\_\_\_\_ (side slopes of breach)  
ELBM = \_\_\_\_\_ (bottom of breach elevation, minimum of  
zero storage elevation)  
WSEL = \_\_\_\_\_ (normal pool elevation)  
T FAIL = \_\_\_\_\_ mins = \_\_\_\_\_ hrs (time for breach to  
develop)







Data for Dam at Outlet of Subarea A-2

Name of Dam: GOULDSBORO DAM

SPILLWAY DATA: FROM PHASE I REPORT  
FOR GOULDSBORO  
DAM - JULY 1979

	Existing Conditions	Design Conditions
Top of Dam Elevation	<u>1901.7</u>	<u>(N/A)</u>
Spillway Crest Elevation	<u>1894.0</u>	
Spillway Head Available (ft)	<u>7.7</u>	
Type Spillway	<u>CONCRETE DROP INLET</u>	
"C" Value - Spillway	<u>2.85</u>	
Crest Length - Spillway (ft)	<u>13.28 (INSIDE LENGTH OF WEIR)</u>	
Spillway Peak Discharge (cfs)	<u>149 *</u>	
Auxiliary Spillway Crest Elev.	<u>1895.5</u>	
Auxiliary Spill. Head Avail. (ft)	<u>6.2</u>	
Type Auxiliary Spillway	<u>OPEN CHANNEL</u>	
"C" Value - Auxiliary Spill. (ft)	<u>N/A</u>	
Crest Length - Auxil. Spill. (ft)	<u>130 (BOTTOM WIDTH)</u>	
Auxiliary Spillway Peak Discharge (cfs)	<u>2970</u>	
Combined Spillway Discharge (cfs)	<u>3119</u>	

\* ASSUMED CONSTANT FOR HEADS  
ABOVE 2.5 FEET

Spillway Rating Curve: (SEE  
BELOW)

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
<u>1894.0</u>			<u>0</u>
<u>1895.0</u>			<u>38</u>
<u>1895.5</u>			<u>69</u>
<u>1896.5</u>			<u>290</u>
<u>1897.5</u>			<u>596</u>
<u>1898.5</u>			<u>1029</u>
<u>1899.5</u>			<u>1570</u>

OUTLET WORKS RATING:

	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	<u>(N/A)</u>	<u>(N/A)</u>	<u>(N/A)</u>
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance			
K Exit			
K Friction = $29.1 N^2 L / R^4 / 3$			
Sum of K			
$(1/K) 0.5 = C$			
Maximum Head (ft) = HM			
$Q = CA \sqrt{2g(HM)} (cfs)$			
Q Combined (cfs)			

Data for Dam at Outlet of Subarea A-4 (See sketch on Sheet D-4)

Name of Dam: CRYSTAL LAKE DAM

STORAGE DATA: TAKEN FROM PHASE I REPORT  
FOR CRYSTAL LAKE DAM

Elevation	Area (acres)	Storage		Remarks
		million gals	acre-ft	
<u>2046.9</u> =ELEVO*	<u>0</u>	<u>0</u>	<u>0</u>	
<u>2055.9</u> =ELEV1	<u>133</u> =A1	<u>130</u>	<u>399</u> =S1	<u>NORMAL POOL</u>
<u>2058.4</u>	<u>132</u>	<u>246</u>	<u>754</u>	<u>TOP OF DAM</u>
<u>2060.0</u>	<u>164</u>	<u>328</u>	<u>1007</u>	
<u>2080.0</u> **	<u>259</u>	<u>1694</u>	<u>5200</u>	

\* ELEVO = ELEV1 - (3S<sub>1</sub>/A<sub>1</sub>)

\*\* Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 27 percent of subarea watershed.

BREACH DATA: BREACH ANALYSIS NOT REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: \_\_\_\_\_

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) \_\_\_\_\_ fps  
(from  $Q = CLH^{3/2} = V \cdot A$  and depth =  $(2/3) \times H$ ) &  $A = L \cdot \text{depth}$

HMAX =  $(4/9 V^2/C^2)$  = \_\_\_\_\_ ft., C = \_\_\_\_\_ Top of Dam El. = \_\_\_\_\_

HMAX + Top of Dam El. = \_\_\_\_\_ = FAILURE  
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = \_\_\_\_\_ ft (width of bottom of breach)  
Z = \_\_\_\_\_ (side slopes of breach)  
ELBM = \_\_\_\_\_ (bottom of breach elevation, minimum of  
zero storage elevation)  
WSEL = \_\_\_\_\_ (normal pool elevation)  
T FAIL = \_\_\_\_\_ mins = \_\_\_\_\_ hrs (time for breach to  
develop)



Data for Dam at Outlet of Subarea A-5 (See sketch on Sheet D-4)

Name of Dam: UPPER KLONDIKE DAM

STORAGE DATA: FROM PHASE I REPORT FOR  
LOWER KLONDIKE DAM

Elevation	Area (acres)	Storage		Remarks
		million gals	acre-ft	
<u>1892.6</u> =ELEVO*	<u>0</u>	<u>0</u>	<u>0</u>	<u>STREAMBED</u>
<u>1902.0</u> =ELEV1	<u>20</u> =A1	<u>20</u>	<u>63</u> =S1	<u>***</u>
<u>1906.6</u>	<u>32</u>	<u>59</u>	<u>101</u>	<u>TOP OF DAM</u>
<u>1920.0</u> **	<u>81</u>	<u>297</u>	<u>910</u>	

\* ELEVO = ELEV1 -  $(3S_1/A_1)$

\*\* Planimetered contour at least 10 feet above top of dam

\*\*\* From Design Drawings

Reservoir Area at Normal Pool is      /      percent of subarea watershed.

BREACH DATA: BREACH ANALYSIS NOT REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection:                     

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601)          fps  
(from  $Q = CLH^{3/2} = V \cdot A$  and depth =  $(2/3) \times H$  &  $A = L \cdot \text{depth}$ )

HMAX =  $(4/9 V^2/C^2)$  =          ft., C =          Top of Dam El. =         

HMAX + Top of Dam El. =          = FAILURE  
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID =          ft (width of bottom of breach)  
Z =          (side slopes of breach)  
ELBM =          (bottom of breach elevation, minimum of  
zero storage elevation)  
WSEL =          (normal pool elevation)  
T FAIL =          mins =          hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A-5

Name of Dam: UPPER KLONDIKE DAM

SPILLWAY DATA: FROM PHASE I REPORT Existing Design  
FOR LOWER KLONDIKE Conditions Conditions  
DAM (1980)

Top of Dam Elevation	<u>1906.6</u>	<u>(N/A)</u>
Spillway Crest Elevation	<u>1902.0</u>	
Spillway Head Available (ft)	<u>4.6</u>	
Type Spillway	<u>BROAD-CRESTED CONCRETE</u>	
"C" Value - Spillway	<u>2.7</u>	
Crest Length - Spillway (ft)	<u>140.0</u>	
Spillway Peak Discharge (cfs)	<u>3729</u>	
Auxiliary Spillway Crest Elev.		
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)		
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway		
Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve:  $Q = CLH^{1.5} = 378H^{1.5}$

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

OUTLET WORKS RATING:

	<u>Outlet 1</u>	<u>Outlet 2</u>	<u>Outlet 3</u>
Invert of Outlet	<u>(N/A)</u>		
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance			
K Exit			
K Friction = $29.1N^2L/R^{4/3}$			
Sum of K			
$(1/K)^{0.5} = C$			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$ (cfs)			
Combined (cfs)			

Data for Dam at Outlet of Subarea A-6 (See sketch on Sheet D-4)

Name of Dam: LOWER KLONDIKE DAM

STORAGE DATA: FROM PHASE I REPORT FOR  
LOWER KLONDIKE DAM

<u>Elevation</u>	<u>Area</u> <u>(acres)</u>	<u>Storage</u>		<u>Remarks</u>
		<u>million</u> <u>gals</u>	<u>acre-ft</u>	
<u>1882.3</u> =ELEVO*	<u>0</u>	<u>0</u>	<u>0</u>	<u>A1 FROM DESIGN</u> <u>DRAWINGS</u>
<u>1895.1</u> =ELEV1	<u>22</u> =A1	<u>31</u>	<u>94</u> =S1	
<u>1899.6</u>	<u>34</u>	<u>71</u>	<u>218</u>	<u>TOP OF DAM</u>
<u>1900.0</u>	<u>35</u>	<u>76</u>	<u>233</u>	<u>DESIGN TOP</u> <u>OF DAM</u>
<u>1920.0 **</u>	<u>150</u>	<u>635</u>	<u>1949</u>	

\* ELEVO = ELEV1 -  $(3S_1/A_1)$

\*\* Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 20 percent of subarea watershed.

BREACH DATA: BREACH ANALYSIS NOT REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: \_\_\_\_\_

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) \_\_\_\_\_ fps  
(from  $Q = CLH^{3/2} = V \cdot A$  and depth =  $(2/3) \times H$  &  $A = L \cdot \text{depth}$ )

HMAX =  $(4/9 V^2/C^2)$  = \_\_\_\_\_ ft., C = \_\_\_\_\_ Top of Dam El. = \_\_\_\_\_

HMAX + Top of Dam El. = \_\_\_\_\_ = FAILURE  
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = \_\_\_\_\_ ft (width of bottom of breach)  
Z = \_\_\_\_\_ (side slopes of breach)  
ELBM = \_\_\_\_\_ (bottom of breach elevation, minimum of  
zero storage elevation)  
WSEL = \_\_\_\_\_ (normal pool elevation)  
T FAIL = \_\_\_\_\_ mins = \_\_\_\_\_ hrs (time for breach to  
develop)



Data for Dam at Outlet of Subarea A-7 (See sketch on Sheet D-4)

Name of Dam: LARSEN

STORAGE DATA:

Elevation	Area (acres)	Storage		Remarks
		million gals	acre-ft	
<u>1871.0</u> -ELEVO*	<u>0</u>	<u>0</u>	<u>0</u>	
<u>1882.6</u> -ELEV1	<u>63.5</u> -A1	<u>80.2896</u>	<u>246.1</u> -S1	<u>OWNER DATA</u>
<u>1885.7</u>	<u>105</u>		<u>504</u>	<u>Top Dam</u>
<u>1886.4</u>	<u>116</u>		<u>581</u>	
<u>1890.0</u>	<u>180</u>			

\* ELEVO = ELEV1 -  $(3S_1/A_1)$

\*\* Planimetered contour <sup>L INTERPOLATED</sup> at ~~least 10 feet~~ above top of dam

Reservoir Area at Normal Pool is 3 percent of subarea watershed.

BREACH DATA: NOT USED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: \_\_\_\_\_

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) \_\_\_\_\_ fps  
(from  $Q = CLH^{3/2} = V \cdot A$  and depth =  $(2/3) \times H$  &  $A = L \cdot \text{depth}$ )

HMAX =  $(4/9 V^2/C^2)$  = \_\_\_\_\_ ft., C = \_\_\_\_\_ Top of Dam El. = \_\_\_\_\_

HMAX + Top of Dam El. = \_\_\_\_\_ = FAILEL  
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = \_\_\_\_\_ ft (width of bottom of breach)  
Z = \_\_\_\_\_ (side slopes of breach)  
ELBM = \_\_\_\_\_ (bottom of breach elevation, minimum of  
zero storage elevation)  
WSEL = \_\_\_\_\_ (normal pool elevation)  
T FAI' = \_\_\_\_\_ mins = \_\_\_\_\_ hrs (time for breach to  
develop)



Data for Dam at Outlet of Subarea A-7

Name of Dam: LARSEN

SPILLWAY DATA:  $Q = CLH^{1.5}$

	Existing Conditions	Design Conditions
Top of Dam Elevation	<u>1885.7</u>	<u>1886.4</u>
Spillway Crest Elevation	<u>1882.6</u>	<u>1882.6</u>
Spillway Head Available (ft)	<u>3.1</u>	<u>3.8</u>
Type Spillway	<u>CONCRETE GRAVITY W/ ROUND CREST</u>	
"C" Value - Spillway	<u>3.4</u>	<u>3.4</u>
Crest Length - Spillway (ft)	<u>70.0</u>	<u>70.0</u>
Spillway Peak Discharge (cfs)	<u>1,299</u>	<u>1,763</u>
Auxiliary Spillway Crest Elev.		
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)		
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway		
Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)	<u>1,299</u>	<u>1,763</u>

Spillway Rating Curve:

★ KINGS HANDBOOK FIG 71

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

OUTLET WORKS RATING:

	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	<u>1874.0</u>	<u>1874.0</u>	
Invert of Inlet	<u>1874+</u>	<u>1874+</u>	
Type	<u>CIP</u>	<u>CIP</u>	
Diameter (ft) = D	<u>2</u>	<u>2</u>	
Length (ft) = L	<u>24</u>	<u>24</u>	
Area (sq. ft) = A	<u>3.14</u>	<u>3.14</u>	
N	<u>0.14</u>	<u>0.14</u>	
K Entrance	<u>0.5</u>	<u>0.5</u>	
K Exit	<u>1.0</u>	<u>1.0</u>	
K Friction = $29.1N^2L/R^{4/3}$	<u>1.34</u>	<u>1.34</u>	
Sum of K	<u>1.84</u>	<u>1.84</u>	
(1/K) 0.5 = C	<u>.74</u>	<u>.74</u>	
Maximum Head (ft) = HM	<u>8+/-</u>	<u>8+/-</u>	
Q = $CA\sqrt{2g(HM)}$ (cfs)	<u>53</u>	<u>53</u>	
Q Combined (cfs)	<u>106</u>		

2 110

D-16

ENDING

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FLOOD HYDROGRAPH PACKAGE (HEC-1)

DAM SAFETY VERSION JULY 1978

LAST MODIFICATION 01 APR 80

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NATIONAL DAM INSPECTION PROGRAM														
LEHIGH RIVER														
LARSEN DAM														
1	A1	300	0	15	0	0	0	0	0	0	0	0	0	0
2	A2													
3	A3													
4	B1	5												
5	B2	1												
6	J1	1												
7	J2	1												
8	K1	0												
9	K2	1												
10	M1	1												
11	P1	1												
12	T1	1												
13	X1	1												
14	X2	1												
15	X3	1												
16	K1	1												
17	V1	1												
18	SA	1												
19	SE1909.4	125												
20	SE1920.0	1920.0												
21	SE1920.0	51.0												
22	SE1921.6	124												
23	SE1921.6	124												
24	SE1921.6	124												
25	SE1921.6	124												
26	K1	1												
27	M1	1												
28	P1	1												
29	T1	1												
30	X1	1												
31	X2	1												
32	X3	1												
33	K1	1												
34	V1	1												
35	Y1	1												
36	Y2	1												
37	Y3	1												
38	Y4	1												
39	SE1894	1894												
40	SE1894	1894												
41	SE1894	1894												
42	SE1894	1894												
43	SE1894	1894												
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48	SE1894	1894												
49	SE1894	1894												
50	SE1894	1894												

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P	21.9	106	119	129	138	1.0	0.05	0.01
T	3.75	0.45						
X	-1.5	-0.05	2.0					
K	2							
K1	COMBINE FLOWS FROM CRYSTAL LAKE AND UPPER KLONDIKE SUB-AREA							
K	1							
K	8							
K	1							
Y	ROUTE THROUGH UPPER KLONDIKE LAKE							
Y1	1							
SA	0	20	32	81				
SE1892.6	1902.0	1906.6	1920.0					
SE1902.0	160	2.7	1.5					
SD1906.6	1	160	345	733	765			
SL	1	160	345	733	765			
SV1906.6	1906.9	1907.0	1907.5	1908.0	1910.0			
K	0							
K1	SUB-AREA RUNOFF LOWER KLONDIKE DAM							
M	1	0.17	15.39					
P	1	21.9	106	119	129	138	1.0	0.05
T	1.21	0.45						0.20
X	-1.5	-0.05	2.0					
K	2							
K1	COMBINE OUTFLOW FROM UPPER KLONDIKE WITH LOWER KLONDIKE SUB-AREA							
K	1							
K	9							
K1	ROUTE THROUGH LOWER KLONDIKE LAKE							
Y	1							
Y1	1							
SA	0	22	34	35	150			
SE1882.3	1895.1	1899.6	1900.0	1920.0				
SE1895.1	138	2.7	1.5					
SD1899.6	1	840	1180	1380				
SL	1	840	1180	1380				
SV1899.6	1900.0	1900.5	1902.0					
K	2							
K1	COMBINE OUTFLOWS FROM KLONDIKE WATANGA & COULDSORO AT JOHNSON POND							
K	0							
K	10							
K1	SUB-AREA RUNOFF JOHNSON POND							
M	1	2.89	15.39					
P	1	21.9	106	119	129	138	1.0	0.05
T	2.83	0.45						0.04
X	-1.5	-0.05	2.0					
K	2							
K1	TOTAL INFLOW TO JOHNSON POND							
K	10							
K1	ROUTE THROUGH LARSEN DAM							
M	1							
Y	1							
Y1	1							

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-1882.6

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SA	0	63.5	180			
SE	1871	1882.6	1890			
SS1882.6		70	3.4	1.5		
SD1885.7						
SL	42	57	90	145	200	222
SV1885.7		1886.2	1886.5	1886.51	1887.2	1888.3
K	1	11				
Y		ROUTE THROUGH LAKE LEHIGH				
Y1	1				0	
SA	0	44	48			
SE1884.0		1873	1880			
SS1873.0		88	3.1	1.5		
SD1873.7						
SL	0	26	115	186	248	278
SV1873.7		1874.0	1874.5	1875.0	1875.5	1876.0
K	99					

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1890  
1  
-1873

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1876.5

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D-21

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS  
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)  
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS							
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8
				1.00	.50	.30	.25	.20	.15	.10	.05
HYDROGRAPH AT	1	2.57 ( 6.66)	1	4.25 ( 130.98)	2533 ( 654.9)	1388 ( 39.29)	1956 ( 32.74)	925 ( 26.20)	694 ( 19.65)	463 ( 13.10)	231 ( 6.55)
ROUTED TO	1	2.57 ( 6.66)	1	4.04 ( 126.08)	2119 ( 59.99)	1103 ( 31.23)	839 ( 23.76)	577 ( 16.33)	368 ( 9.85)	210 ( 5.96)	89 ( 2.53)
HYDROGRAPH AT	2	3.88 ( 10.05)	1	5.25 ( 148.71)	2026 ( 76.35)	1575 ( 44.61)	1313 ( 37.18)	1050 ( 29.74)	788 ( 22.31)	525 ( 14.87)	263 ( 7.44)
ROUTED TO	2	3.88 ( 10.05)	1	10.64 ( 30.12)	306 ( 8.66)	101 ( 2.86)	62 ( 1.76)	45 ( 1.29)	32 ( .91)	21 ( .60)	11 ( .30)
2 COMBINED	A	6.45 ( 16.71)	1	4.38 ( 131.34)	2159 ( 61.13)	1131 ( 32.04)	865 ( 24.51)	599 ( 16.98)	368 ( 10.41)	224 ( 6.38)	97 ( 2.74)
ROUTED TO	3	6.45 ( 16.71)	1	4.25 ( 130.97)	2153 ( 60.95)	1124 ( 31.84)	840 ( 24.37)	596 ( 16.89)	366 ( 10.38)	224 ( 6.34)	97 ( 2.73)
HYDROGRAPH AT	3	.22 ( 1.09)	1	7.55 ( 21.38)	378 ( 10.69)	227 ( 6.41)	189 ( 5.35)	151 ( 4.28)	113 ( 3.21)	76 ( 2.14)	38 ( 1.07)
2 COMBINED	3	6.87 ( 17.79)	1	5.34 ( 151.27)	2491 ( 70.54)	1299 ( 36.78)	992 ( 28.08)	686 ( 19.42)	422 ( 11.94)	258 ( 7.31)	131 ( 3.15)
HYDROGRAPH AT	4	.77 ( 1.99)	1	1730 ( 49.00)	865 ( 24.50)	519 ( 14.70)	433 ( 12.25)	346 ( 9.80)	260 ( 7.35)	173 ( 4.90)	87 ( 2.45)
ROUTED TO	4	.77 ( 1.99)	1	1201 ( 34.02)	257 ( 7.28)	134 ( 3.78)	105 ( 2.94)	78 ( 2.22)	54 ( 1.52)	31 ( .88)	12 ( .34)
ROUTED TO	5	.77 ( 1.99)	1	1125 ( 31.85)	254 ( 7.18)	132 ( 3.74)	104 ( 2.95)	78 ( 2.20)	52 ( 1.48)	30 ( .86)	12 ( .34)
ROUTED TO	6	.77 ( 1.99)	1	1046 ( 29.62)	251 ( 7.10)	131 ( 3.70)	103 ( 2.91)	76 ( 2.17)	52 ( 1.47)	30 ( .86)	12 ( .34)
ROUTED TO	7	.77 ( 1.99)	1	966 ( 27.36)	247 ( 7.00)	128 ( 3.63)	101 ( 2.86)	75 ( 2.15)	51 ( 1.45)	30 ( .85)	12 ( .33)
HYDROGRAPH AT	8	4.09 ( 12.15)	1	6113 ( 173.11)	3057 ( 86.56)	1834 ( 51.95)	1528 ( 43.28)	1223 ( 36.62)	917 ( 25.97)	611 ( 17.51)	304 ( 8.66)
2 COMBINED	8	5.46 ( 16.14)	1	6624 ( 187.56)	3164 ( 89.59)	1883 ( 53.33)	1566 ( 44.35)	1251 ( 35.42)	937 ( 26.53)	624 ( 17.66)	310 ( 8.79)
ROUTED TO	9	5.46 ( 16.14)	1	6622 ( 187.53)	3138 ( 88.86)	1866 ( 52.85)	1551 ( 43.93)	1238 ( 35.06)	926 ( 26.21)	614 ( 17.39)	304 ( 8.61)

LAKE WATANGA

GOULDSBORO DAM

CRYSTAL LAKE

UPPER KIAMOISE

HYDROGRAPH AT	9	.17 (.44)	1	430. (12.19)	215. (6.09)	129. (3.66)	108. (3.05)	86. (2.44)	65. (1.83)	43. (1.22)	22. (.61)
2 COMBINED	9	5.63 (14.58)	1	6791. (192.31)	3232. (91.53)	1923. (54.45)	1599. (45.27)	1276. (36.13)	954. (27.01)	633. (17.93)	333. (8.95)
ROUTED TO	9	5.63 (14.58)	1	6792. (192.36)	3205. (90.76)	1904. (53.92)	1582. (44.79)	1261. (35.71)	942. (26.68)	626. (17.66)	304. (8.68)
2 COMBINED	10	12.50 (32.37)	1	11893. (336.74)	5610. (158.86)	3203. (90.70)	2573. (72.85)	1933. (54.73)	1349. (38.20)	875. (24.78)	414. (11.73)
HYDROGRAPH AT	10	2.89 (7.49)	1	4553. (128.93)	2277. (64.47)	1366. (38.68)	1138. (32.23)	911. (25.79)	683. (19.34)	455. (12.89)	228. (6.43)
2 COMBINED	10	15.39 (39.86)	1	16278. (460.99)	7745. (219.32)	4427. (125.37)	3564. (100.91)	2704. (76.63)	1944. (55.03)	1267. (35.88)	607. (17.18)
ROUTED TO	10	15.39 (39.86)	1	15702. (444.64)	7418. (210.06)	4164. (117.96)	3326. (94.19)	2484. (70.33)	1715. (48.54)	1091. (30.98)	519. (14.47)
ROUTED TO	11	15.39 (39.86)	1	15673. (443.80)	7400. (209.53)	4151. (117.55)	3314. (93.83)	2472. (70.01)	1707. (48.35)	1084. (30.70)	500. (14.14)

LOWER KLOHSEGE

LAASSEN DAM

LAKE LENSEN



RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1891.94	6.24	1497.	15702.	28.75	44.00	0.00
.90	1889.31	3.61	990.	7418.	19.00	44.25	0.00
.80	1887.92	2.22	777.	4166.	13.50	44.75	0.00
.75	1887.48	1.78	716.	3526.	11.75	45.00	0.00
.70	1886.94	1.26	646.	2484.	9.75	45.25	0.00
.65	1886.24	.56	564.	1715.	6.50	45.75	0.00
.60	1885.36	0.00	469.	1091.	0.00	46.00	0.00
.55	1884.26	0.00	368.	511.	0.00	46.25	0.00

# SUMMARY OF DAM SAFETY ANALYSIS

## LAKE LEHIGH

INITIAL VALUE 1873.00  
 SPILLWAY CREST 1873.00  
 TOP OF DAM 1873.70  
 132.00  
 163.00  
 160.00

ELEVATION  
 STORAGE  
 OUTFLOW

PLAN 1 .....

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1880.04	6.34	456.	15673.	51.75	44.00	0.00
.50	1877.75	4.05	347.	7400.	41.25	44.50	0.00
.30	1876.60	2.90	294.	4151.	38.75	45.00	0.00
.25	1876.26	2.56	278.	3314.	37.75	45.25	0.00
.20	1875.86	2.16	260.	2472.	33.75	45.75	0.00
.15	1875.44	1.74	241.	1707.	30.25	46.00	0.00
.10	1875.00	1.30	221.	1084.	25.50	46.50	0.00
.05	1874.59	.69	194.	500.	17.75	47.25	0.00

BY \_\_\_\_\_ DATE \_\_\_\_\_  
CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

SUBJECT \_\_\_\_\_

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_  
JOB NO. \_\_\_\_\_

## SUMMARY OF PERTINENT RESULTS

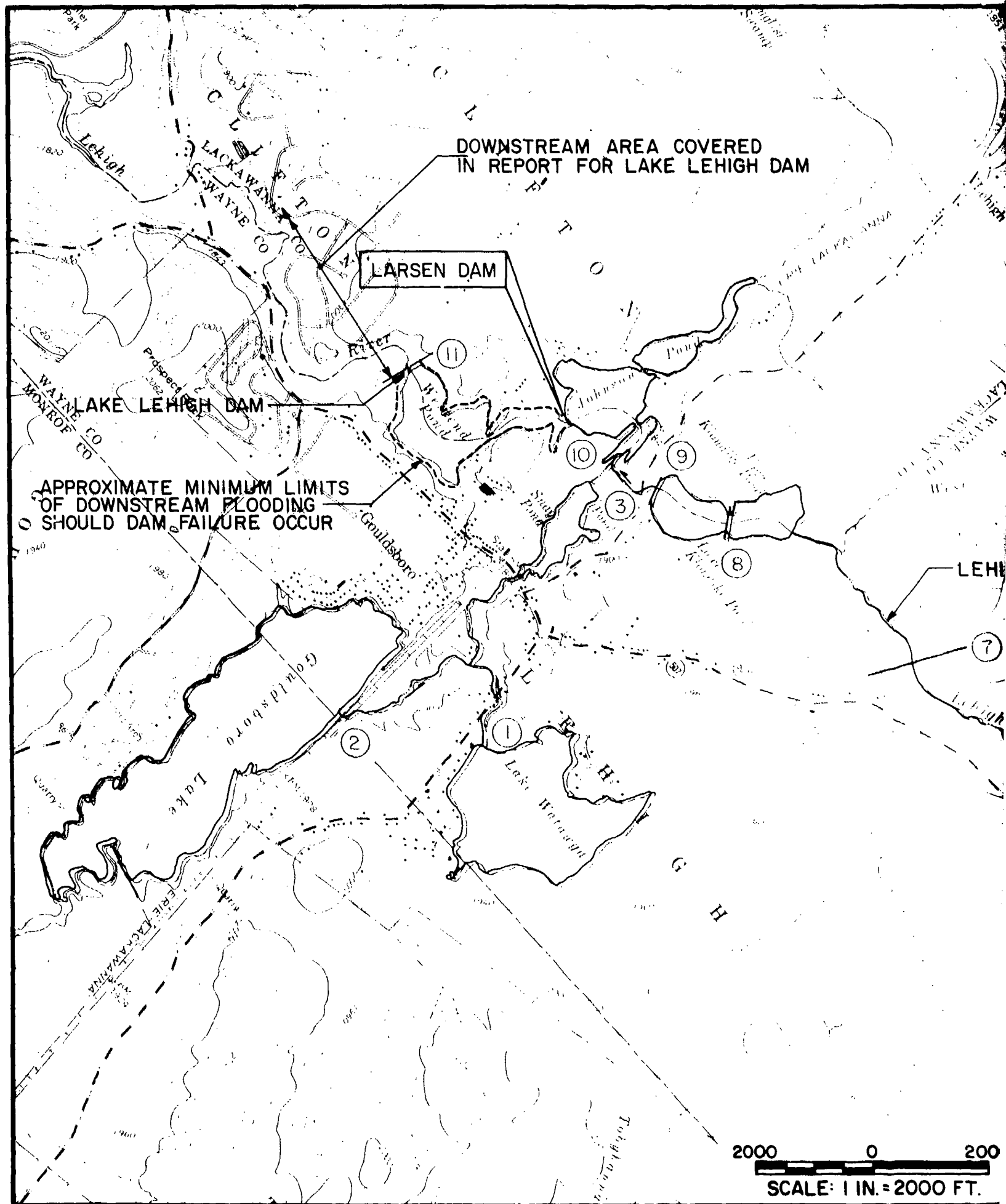
	<u>PMF</u>	<u>1/2 PMF = SDF</u>
RAINFALL (INCHES)	24.62	-

### LARSEN DAM (ASSUMING DAM REMAINS INTACT)

RUNOFF - APPROX. (INCHES)	22.39	11.19
INFLOW (CFS)	16,278	7,745
OUTFLOW (CFS)	15,702	7,418
Depth OVERTOPPING (FT)	6.24	3.61
DURATION OVERTOPPING (HRS)	28.75	19.00

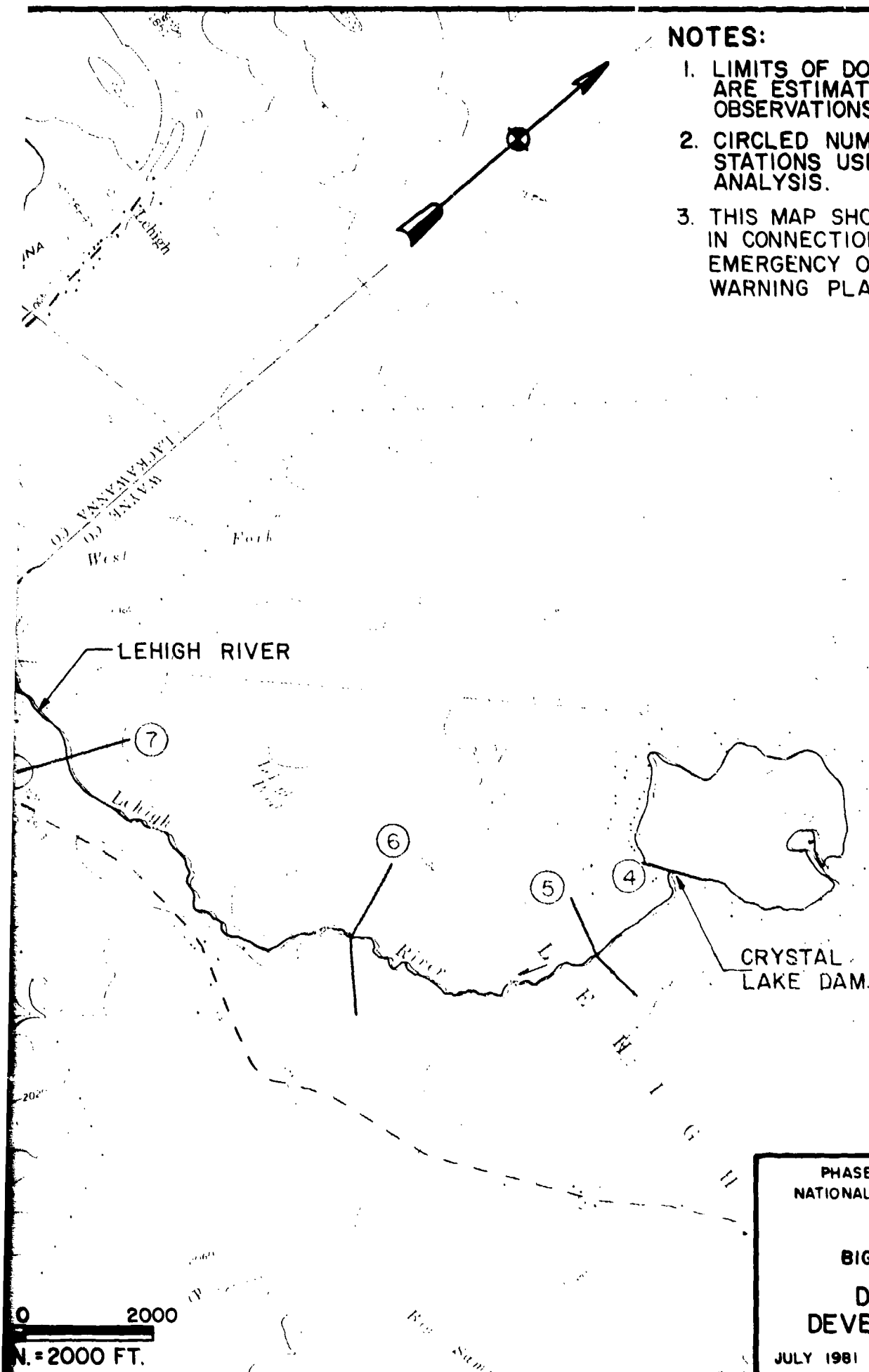
### EXISTING LAKE LEHIGH (ASSUMING DAM REMAINS INTACT)

INFLOW (CFS)	15,702	7,418
OUTFLOW (CFS)	15,673	7,400
Depth OVERTOPPING (FT)	6.34	4.05
DURATION OVERTOPPING (HRS)	51.75	41.25



### NOTES:

1. LIMITS OF DOWNSTREAM FLOODING ARE ESTIMATES BASED ON VISUAL OBSERVATIONS.
2. CIRCLED NUMBERS INDICATE STATIONS USED IN COMPUTER ANALYSIS.
3. THIS MAP SHOULD NOT BE USED IN CONNECTION WITH THE EMERGENCY OPERATION AND WARNING PLAN.



PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM

LARSEN DAM

BIG BASS LAKE, INC.

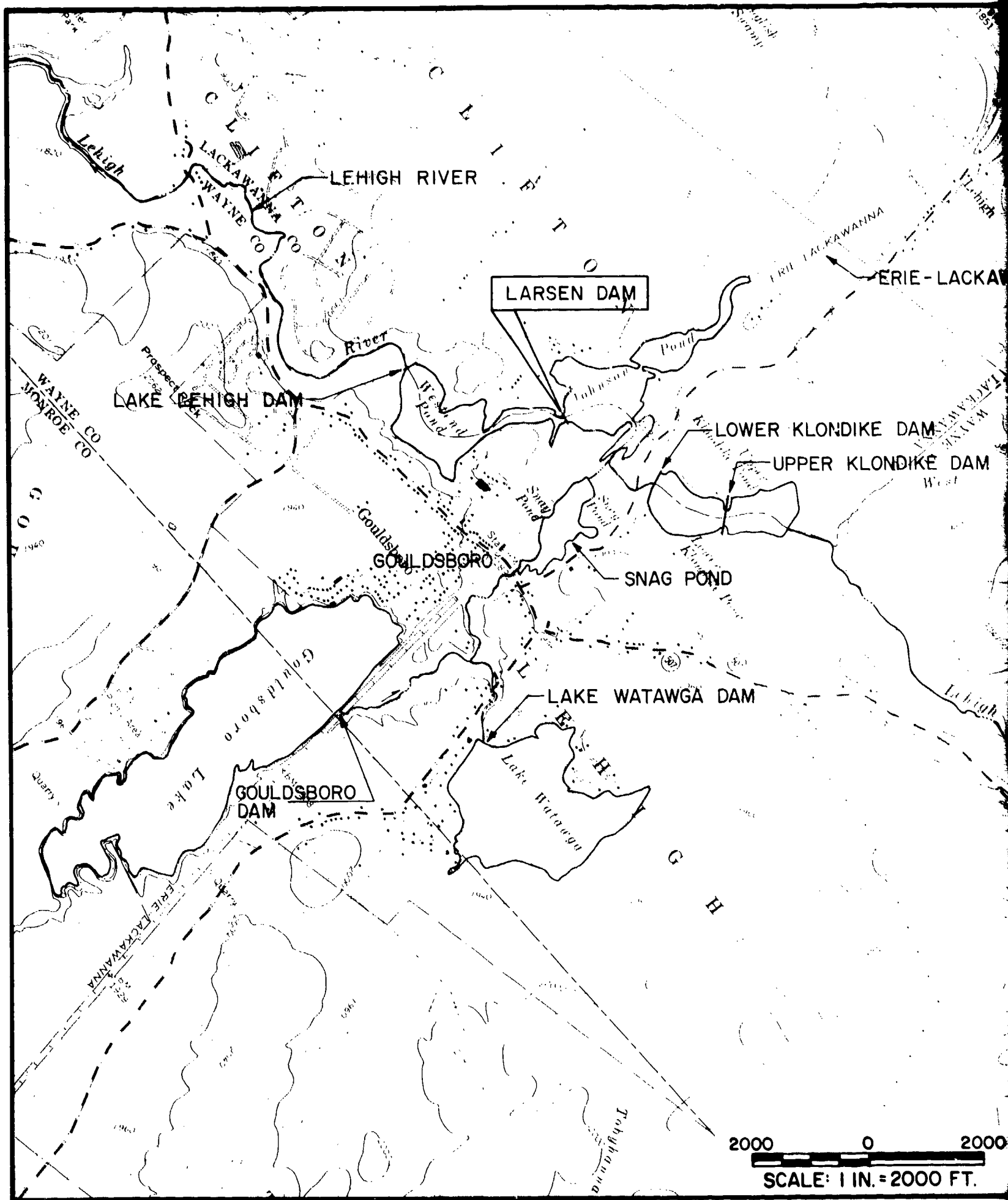
DOWNSTREAM  
DEVELOPMENT PLAN

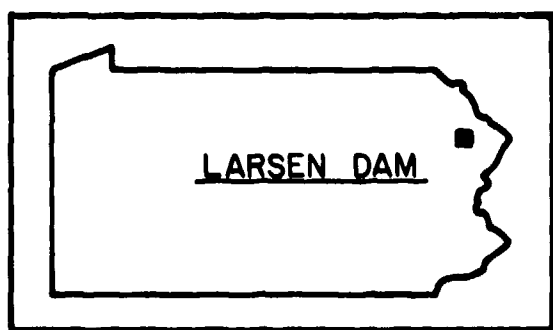
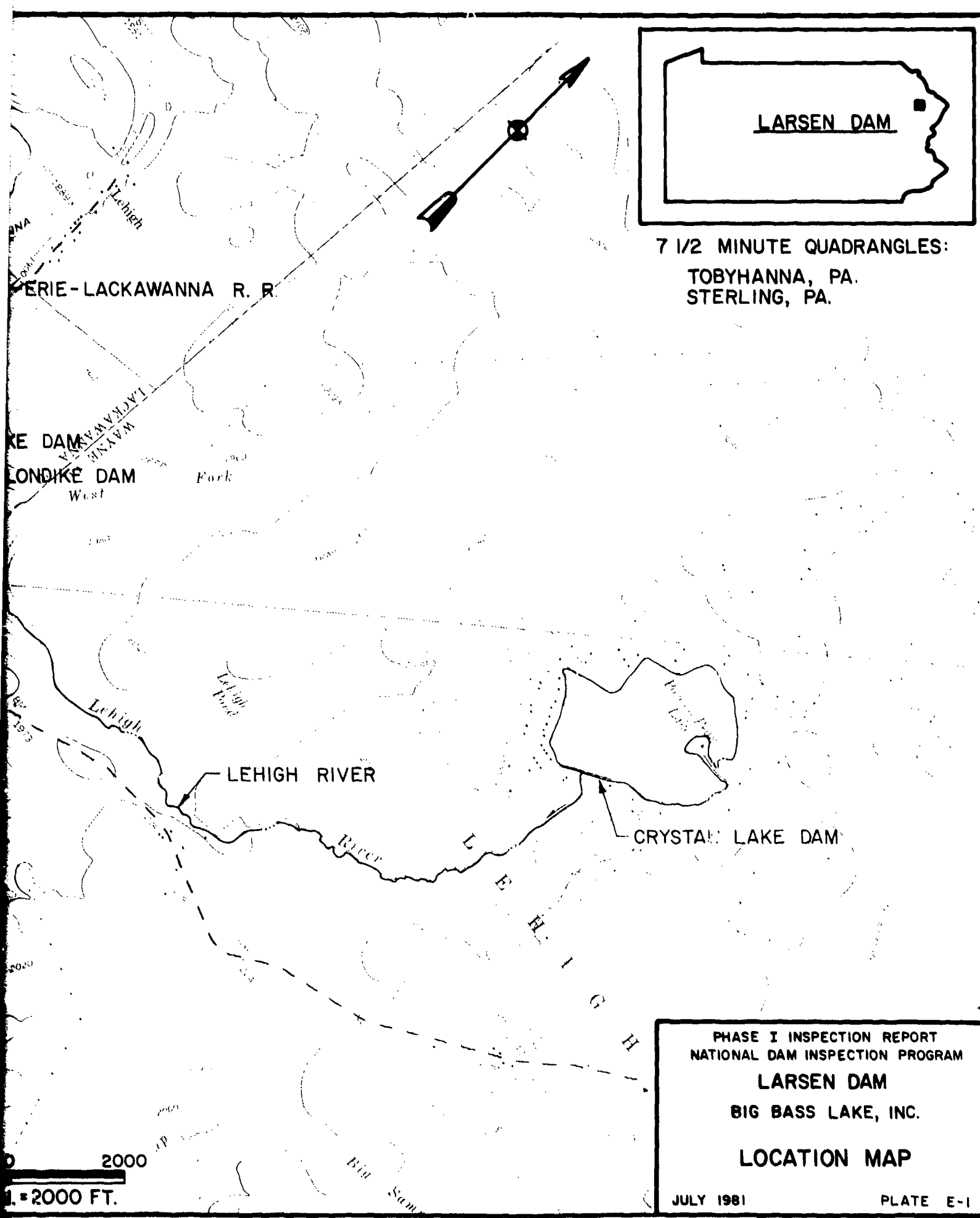
JULY 1981

EXHIBIT D-1

APPENDIX E

PLATES



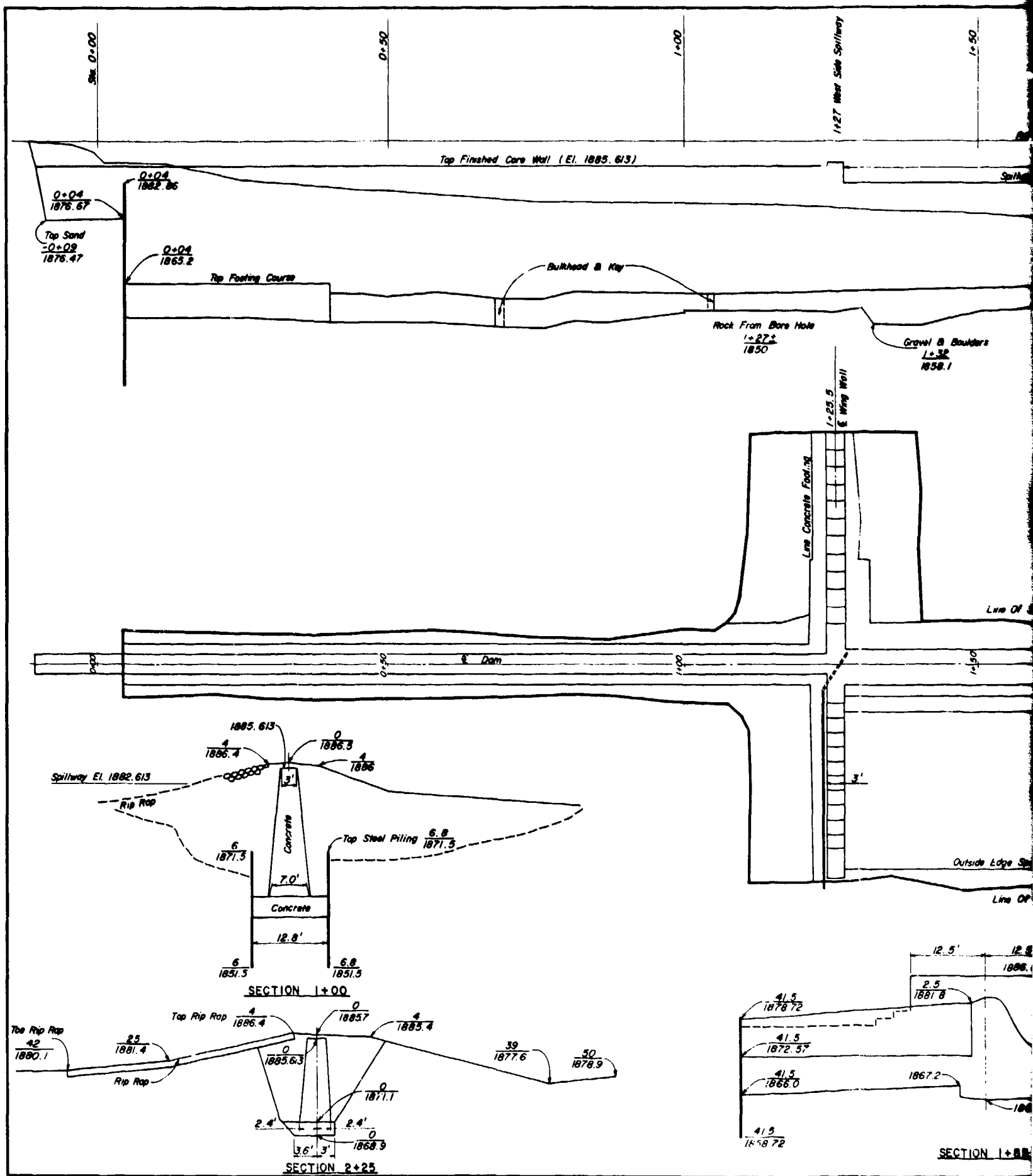


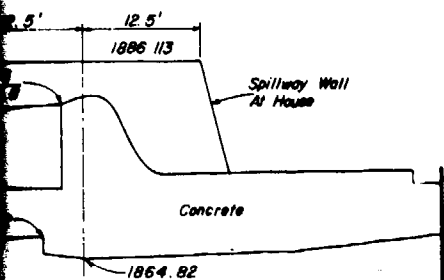
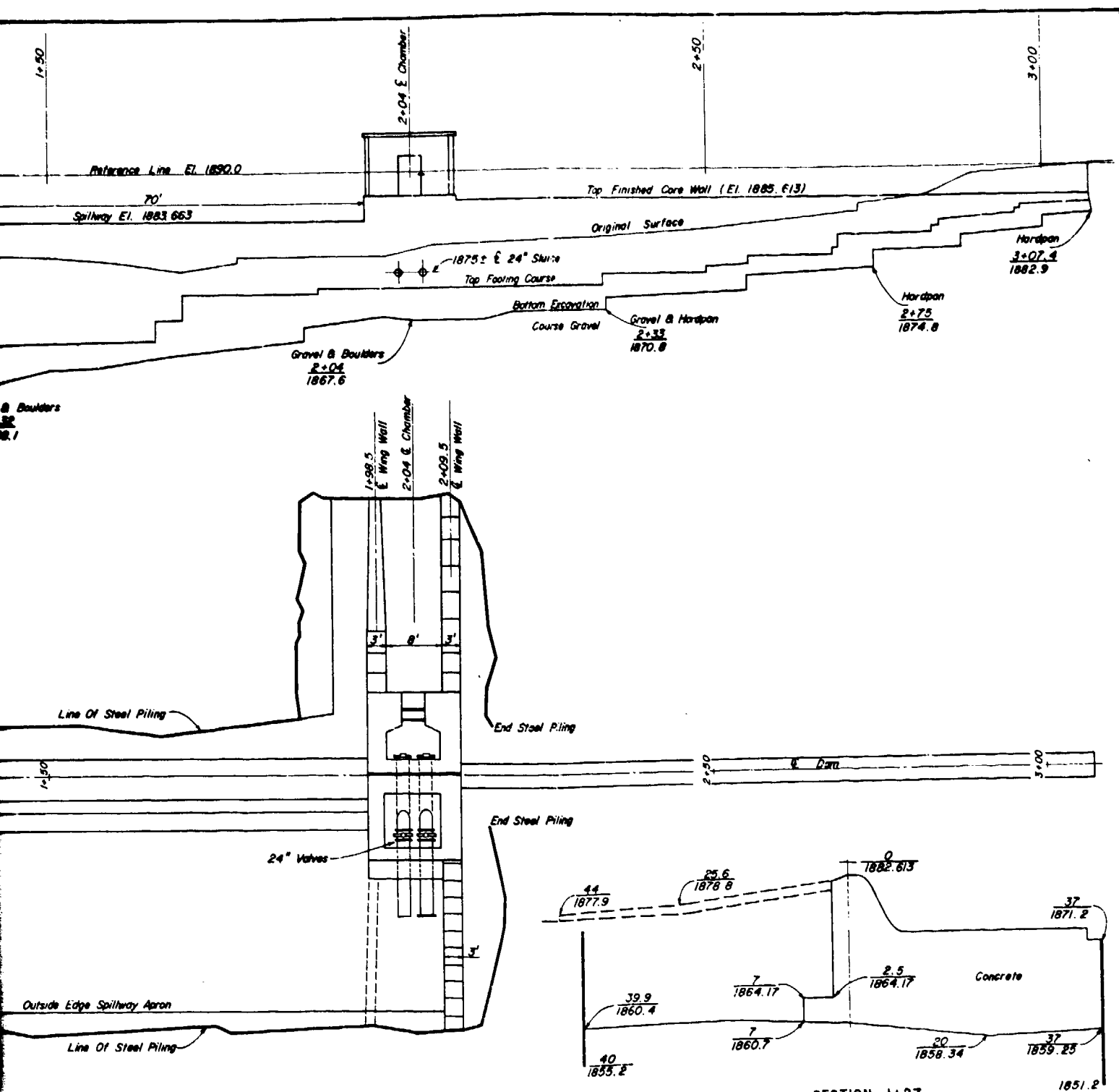
7 1/2 MINUTE QUADRANGLES:  
TOBYHANNA, PA.  
STERLING, PA.

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM  
**LARSEN DAM**  
BIG BASS LAKE, INC.  
**LOCATION MAP**  
JULY 1981  
PLATE E-1

2000  
1. = 2000 FT.







#### NOTE

THIS PLATE WAS TRACED FROM A  
DRAWING IN PENNER FILES TITLED  
"S G & W. CO.  
GOULDSBORO DAM  
COPIED FROM PROGRESS SHEETS  
NOV. 11 1914"

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM

## LARSEN DAM BIG BASS LAKE, INC. PLAN PROFILE AND DETAILS

JULY 1981

EXHIBIT E-2

APPENDIX F

GEOLOGY

## LAKE LEHIGH DAM

### APPENDIX F

#### GEOLOGY

Larsen Dam is located in Wayne County within the Appalachian Plateau Physiographic Province. The most pronounced topographic feature in the area is Camelback Mountain, which is part of the Pocono Plateau Escarpment. This escarpment has a well defined, southwestward trend from Camelback Mountain, but is irregular between Camelback Mountain and Mt. Pocono, which lies to the north. Streams east of the escarpment drain directly to the Delaware River, while those to the west drain to the Lehigh River.

The Pocono Plateau Section lies to the west of the escarpment. This area is relatively flat, with local relief seldom exceeding 100 feet. The topography has been greatly influenced by continental glaciation. Many features were created by deposition of glacial materials. The entire plateau lacks well-developed drainage.

East of the escarpment is the Glaciated Low Plateaus Section of the province. This area is characterized by pre-glacial erosional topography with locally thick glacial deposits. Local relief is generally 100 to 300 feet.

Bedrock units of the sections described above are the lithified sediments of offshore marine, marginal marine, deltaic and fluvial environments associated with the Devonian Period. These units include siltstones of the Mahantango Formation, siltstones and shales of the Trimmers Rock Formation, and seven mapped members of the Catskill Formation. These members include sandstones, siltstones, and shales of the Towamensing Member; sandstone, siltstone and shales of the Walcksville Member; sandstones, siltstones, and shale of the Beaverdam Run Member; sandstone and shale of the Long Run Member; sandstones and conglomerates in the Packerton Member; sandstone and some conglomerates in the Poplar Gap Member; and sandstones and conglomerates in the Duncannon Member.

Larsen Dam is underlain by the Duncannon Member of the Catskill Formation. The Duncannon Member is predominantly a conglomerate and sandstone unit with some red siltstone and shale. Conglomerates present are generally thick-bedded with subangular to well-rounded quartz pebbles in a coarse-grained sandstone matrix. They are very well indurated and have low porosity due to silica cementation. The sandstones are predominantly fine- to medium-grained, thin- to thick-bedded and well-indurated with a clay and silica cement. Red

sandstones near the top of the unit grade into red siltstone and shale, marking the contact with the Spechty Kopf Formation. The Duncannon Member maintains very steep cut slopes and is reported to be an excellent foundation for heavy structures.

Bedrock is almost entirely overlain by glacial till of Late Wisconsin Age. This till is basically an unsorted mixture of clay, silt, sand, and gravel. It is moderately cohesive and is generally derived locally from the sandstones of the Catskill Formation. Thickness of the till varies from 3 to 100 feet, with an average thickness of 45 feet. Available information indicates that the dam is probably founded on this till.

